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D'APPOLONIA CONSULTING ENGINEERS INC PITTSBURGH PA
NATIONAL DAM INSPECTION PROGRAM. BRADY'S RUN DAM. (NDII.D.-PA-2--ETC(U)
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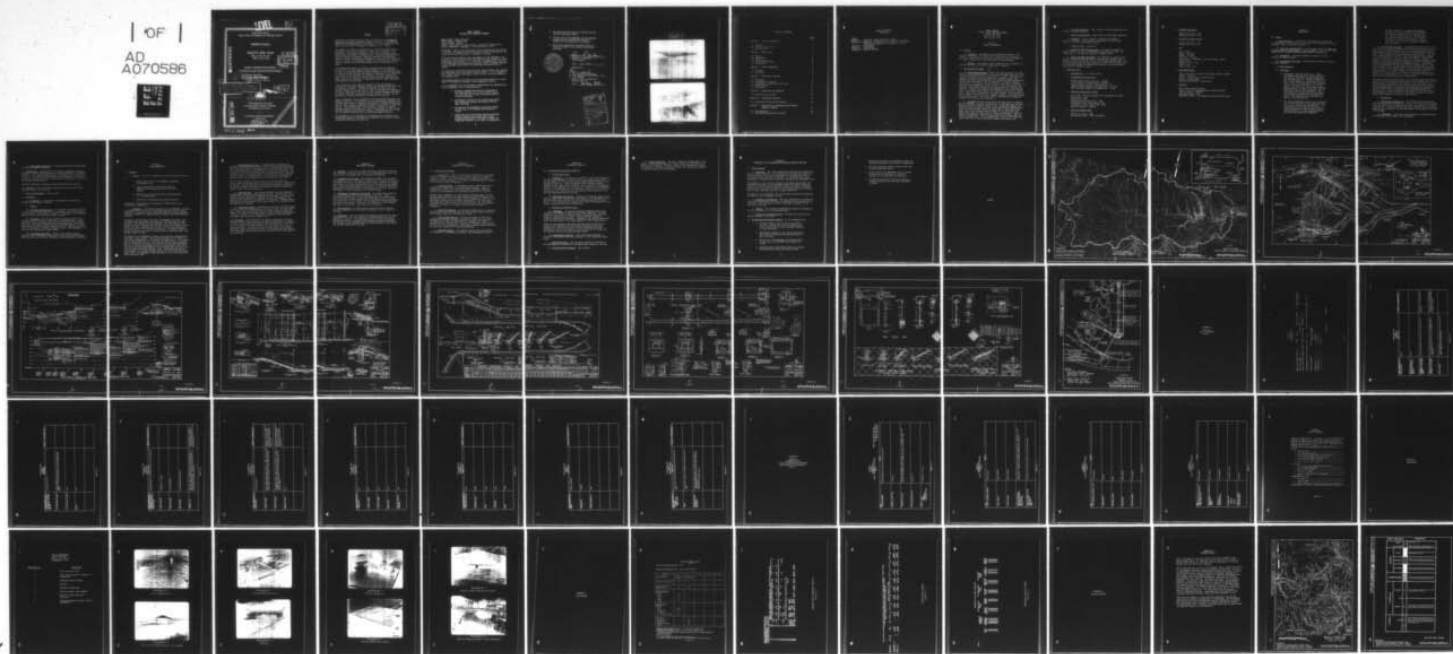
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OHIO RIVER BASIN
SOUTH FORK OF BRADYS RUN, BEAVER COUNTY

PENNSYLVANIA

BRADY'S RUN DAM

NDI I.D. NO: PA-257

DER I.D. NO: 4-35

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PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

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(6) National Dam Inspection Program.
Brady's Run Dam, (NDI PA-257, DER 4-35),
Ohio River Basin, South Fork of Brady's
Run, Beaver County, Pennsylvania. Phase
I Inspection Report.

(12) 68 p.



PREPARED FOR

DEPARTMENT OF THE ARMY
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BALTIMORE, MARYLAND 21203

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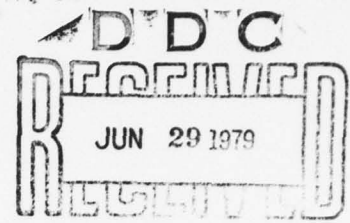
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PREFACE

This report is prepared under guidance contained in the Recommended Guidelines for Safety Inspection of Dams, for Phase I Investigations. Copies of these guidelines may be obtained from the Department of the Army, Office of Chief of Engineers, Washington, D.C. 20314.

The purpose of a Phase I investigation is to identify expeditiously those dams which may pose hazards to human life or property. The assessment of the general condition of the dam is based upon visual observations and review of available data. Detailed investigation and analyses involving topographic mapping, subsurface investigations, material testing, and detailed computational evaluations are beyond the scope of a Phase I investigation; however, the inspection is intended to identify any need for such studies which should be performed by the owner.

In reviewing this report, it should be realized that the reported condition of the dam is based on observations of field conditions at the time of inspection along with data available to the inspection team. In cases where the reservoir was lowered or drained prior to inspection, such action, while improving the stability of the dam, removes the normal load on the structure and may obscure certain conditions which might otherwise be detectable if inspected under the normal operating environment of the structure.

It is important to note that the condition of the dam depends on numerous and constantly changing internal and external factors which are evolutionary in nature. It would be incorrect to assume that the present condition of the dam will continue to represent the condition of the dam at some point in the future. Only through frequent inspections can unsafe conditions be detected and only through continued care and maintenance can these conditions be prevented or corrected.

Phase I inspections are not intended to provide detailed hydrologic and hydraulic analyses. In accordance with the established Guidelines, the spillway design flood is based on the estimated "Probable Maximum Flood" for the region (greatest reasonably possible storm runoff), or fractions thereof. The spillway design flood provides a measure of relative spillway capacity and serves as an aid in determining the need for more detailed hydrologic and hydraulic studies, considering the size of the dam, its general condition and the downstream damage potential.

The assessment of the conditions and recommendations was made by the consulting engineer in accordance with generally and currently accepted engineering principles and practices.

PHASE I REPORT
NATIONAL DAM INSPECTION PROGRAM

NAME OF DAM: Brady's Run Dam
STATE LOCATED: Pennsylvania
COUNTY LOCATED: Beaver
STREAM: South Branch of Brady's Run, a tributary of Beaver River
DATE OF INSPECTION: December 14, 1978 and April 16, 1979

ASSESSMENT: Based on the evaluation of the conditions as they existed on the dates of inspection and as revealed by visual observations, the condition of Brady's Run Dam is considered to be good.

Field observations indicate that two segments of the embankment, one adjacent to the spillway and the other near the right abutment (looking downstream), have settled. It is therefore recommended that the crest of the dam should be surveyed and low spots filled to design elevation. Erosion ditches on each side of the spillway chute should also be filled.

Two structural cracks were observed in the right spillway wall upstream and downstream from the spillway overflow section. It is recommended that remedial work be performed to avoid further structural damage to the spillway walls.

The spillway capacity was found to pass 100 percent PMF and is classified to be adequate according to the recommended criteria.

It is recommended that the following recommendations be implemented as soon as possible or on a continuing basis:

1. Necessary remedial work should be performed on the right spillway wall to avoid further structural distress and to insure continued stability of these structures.
2. Operational condition of the outlet works sluice gate should be evaluated and necessary maintenance performed.
3. Low spots on the embankment and erosion ditches on each side of the spillway chute should be filled.
4. Around-the-clock surveillance should be provided during unusually heavy runoff and a formal warning system should be developed to alert the downstream residents in the event of emergencies.

5. The trees and brush should be removed from the spillway discharge channel.
6. The wet area on the embankment and the seepage points should be periodically observed to document if the conditions are changing.
7. The dam and appurtenant structures should be inspected regularly and necessary maintenance performed.



Lawrence D. Andersen

Lawrence D. Andersen
Vice President

Date: May 3, 1979

Approved By:

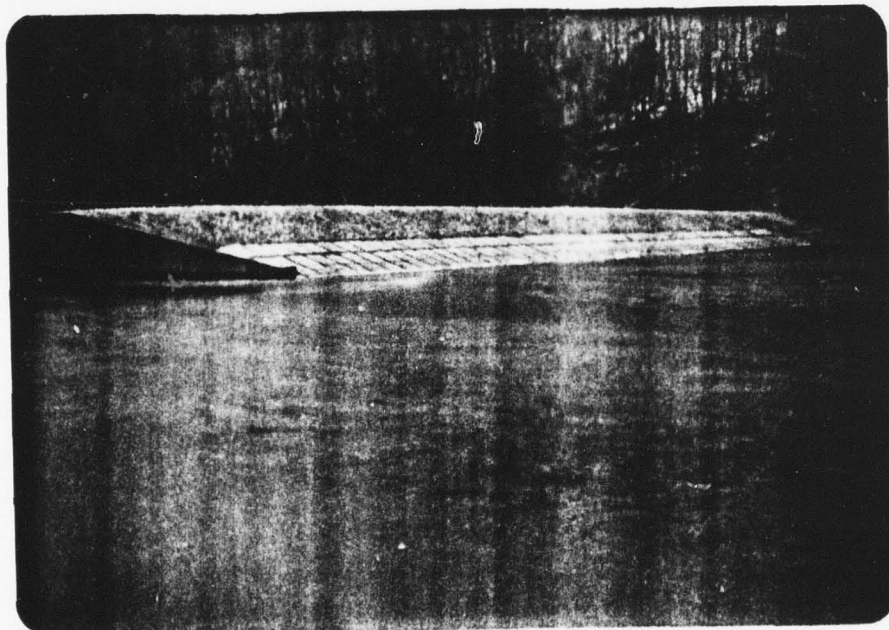
G. K. Withers

G. K. WITHERS
Colonel, Corps of Engineers
District Engineer

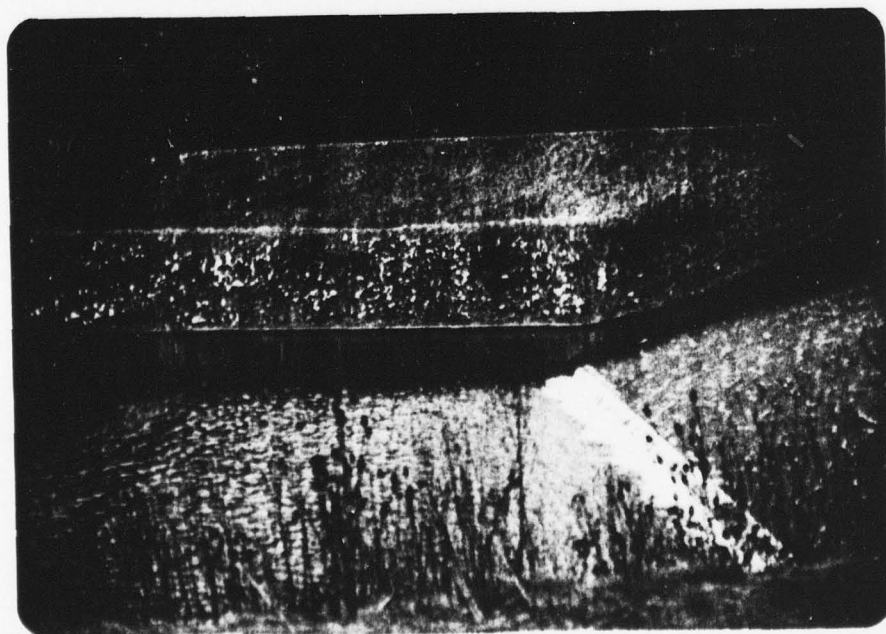
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BRADY'S RUN DAM
NDI I.D. NO. PA-257
DECEMBER 14, 1978



Upstream Face



Downstream Face

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PHASE I REPORT
NATIONAL DAM INSPECTION PROGRAM
BRADY'S RUN DAM
NDI I.D. NO. PA-257
DER I.D. NO. 4-35

SECTION 1
PROJECT INFORMATION

1.1 General

a. Authority. The inspection was performed pursuant to the authority granted by The National Dam Inspection Act, Public Law 92-367, to the Secretary of the Army, through the Corps of Engineers, to conduct inspections of dams throughout the United States.

b. Purpose. The purpose of this inspection is to determine if the dam constitutes a hazard to human life or property.

1.2 Description of Project

ABSTRACT
↓
a. Dam and Appurtenances. Brady's Run Dam consists of an earth embankment approximately 350 feet long with a maximum height of 33 feet from the downstream toe and a crest width of 12 feet. The flood discharge facilities for the dam consist of a combined primary and emergency spillway located near the left abutment (looking downstream). The spillway structures of the dam consist of a concrete overflow section, and a rectangular concrete spillway chute which terminates in a concrete-lined plunge pool at the toe level of the dam near the left abutment. The overflow structure of the spillway is a 135-foot-long ogee weir located at an elevation approximately 10 feet below the dam crest. The outlet works consist of a reinforced concrete box culvert and a control tower located near the right abutment. Flow through the outlet conduit is controlled by a manually operated sluice gate located at the control tower. The outlet conduit constitutes the emergency drawdown facilities for the reservoir.

b. Location. → The dam is located on the South Branch of Brady's Run approximately one mile upstream from its confluence with the North Branch in Brighton Township, Beaver County, Pennsylvania. (Plate 1). Downstream from the dam, the stream flows approximately one mile east, where it joins the North Branch of Brady's Run to form Brady's Run. Brady's Run flows through a narrow valley for two miles and joins Beaver River about one mile north of Beaver, Pennsylvania. There are numerous residential, commercial and industrial buildings along the course of Brady's Run. It is estimated that failure of the dam would cause large loss of life and property damage along Brady's Run.

ABSTRACT

c. Size Classification. Small (based on 33-foot-height and 560 acre-feet storage capacity).

d. Hazard Classification. High (based on downstream conditions).

e. Ownership. County of Beaver, Pennsylvania (address: Mr. Robert Hardesky, Superintendent, Department of Public Works, Route 51, Fallston, Pennsylvania 15066).

f. Purpose of Dam. Recreation.

g. Design and Construction History. The dam was designed by Michael Baker, Jr., Inc., of Rochester, Pennsylvania in 1948. The construction of the dam was completed in December 1949.

h. Normal Operating Procedure. The reservoir is normally maintained at Elevation 828, the level of uncontrolled spillway crest, leaving 10 feet of freeboard to the top of dam at Elevation 838. The inflow occurring when the lake level is at or above the spillway level is discharged through the uncontrolled spillway. The outlet works sluice gate is normally closed.

1.3 Pertinent Data

a. Drainage Area - 13.8 square miles

b. Discharge at Dam Site (cfs)

Maximum known flood at dam site - Unknown

Outlet conduit at maximum pool - Unknown

Gated spillway capacity at maximum pool - N/A

Ungated spillway capacity at maximum pool - 15,400

Total spillway capacity at maximum pool - 15,400

c. Elevation (USGS Datum) (feet)

Top of dam - 838 (as designed); 837.2 (measured low spot)

Maximum pool - 838

Normal pool - 828

Upstream invert outlet works - 806

Downstream invert outlet works - 805

Streambed at center line of dam - 805+

Maximum tailwater - Unknown

d. Reservoir Length (feet)

Normal pool level - 3000

Maximum pool level - 3500 (estimated)

e. Storage (acre-feet)

Normal pool level - 230
Maximum pool level - 560

f. Reservoir Surface (acres)

Normal pool level - 28
Maximum pool level - 38

g. Dam

Type - Earth
Length - 350 feet
Height - 33 feet
Top width - 12 feet
Side slopes - Downstream: 2H:1V; Upstream: 3H:1V
Zoning - Yes
Impervious core - Yes
Cutoff - Yes
Grout curtain - No

h. Regulating Outlet

Type - Four-foot by six-foot reinforced concrete conduit
Length - 160 feet
Closure - Sluice gate at control tower
Access - Control tower
Regulating facilities - Sluice gate

i. Spillway

Type - Ogee overflow section
Length - 135 feet (perpendicular to flow direction)
Crest elevation - 928 feet
Upstream channel - Lake
Downstream channel - Rectangular concrete spillway chute

SECTION 2 DESIGN DATA

2.1 Design

a. Data Available. The available information was provided by the Commonwealth of Pennsylvania, Department of Environmental Resources (PennDER), and by the County of Beaver.

(1) Hydrology and Hydraulics. A state report entitled, Report on the Application of Commissioners, County of Beaver, dated July 17, 1948, summarizes the available hydrology and hydraulic information.

(2) Embankment. Available information consists of design drawings and specifications.

(3) Appurtenant Structures. The available information consists of design drawings.

b. Design Features

(1) Embankment

a. As designed, the dam (Plate 2) is a zoned embankment consisting of a central impervious core section with shell sections downstream and upstream (Plate 3). Along the axis of the dam, a steel sheet-pile wall driven from the base to top of rock constitutes the foundation cutoff. The clay core section, with a top width of 10 feet at the crest level and with a maximum width of 58 feet at the base, extends the entire length of the embankment. The impervious core is keyed into the foundation soil through a minimum four-foot-deep cutoff trench. The sheet-pile wall protrudes two feet into the central core.

b. The dam was designed to have a 2 to 1 (horizontal to vertical) slope on the downstream face and a 3 to 1 slope on the upstream face. The upstream slope of the dam is protected by a 15-foot-wide strip of cast-in-place concrete slabs extending to a level approximately two feet below the normal pool elevation.

- c. As shown in Plate 3, at least seven borings were drilled for the subsurface investigation. The typical subsurface profile consists of up to 25 feet of residual soil on the left abutment and the valley floor and 5 to 10 feet of residual soil on the right abutment. Foundation rock was classified as weathered sandstone with clay seams.

(2) Appurtenant Structures. The appurtenant structures of the dam consist of a combined emergency and primary spillway and the outlet works. The spillway structures consist of an ogee overflow section, a rectangular concrete spillway chute, and a concrete-lined stilling basin. The spillway plan and profile are shown in Plate 4. The 135-foot concrete overflow section is located at Elevation 828, leaving 10 feet of freeboard to the top of dam, as designed. The approach channel is an unlined channel excavated into the left abutment. The bottom of the approach channel as designed is located at Elevation 824, leaving a 4-foot approach depth at normal pool level. The spillway chute is approximately 96 feet long from the overflow section to the stilling basin. The concrete walls of the spillway chutes are cantilever type and have a maximum height of about 20 feet at the spillway control section. The slab sections are 12 inches thick and are underlain by a drain system. A drain system is also located on the outside of the cantilever walls. Plate 5 illustrates the structural details of the spillway walls and stilling basin.

The outlet works are located about 70 feet from the right abutment and consist of a 4-foot by 6-foot reinforced concrete conduit and a control tower located at midlength of the conduit. The outlet conduit is equipped with trash racks at the upstream end and an outlet structure at the downstream end. The conduit is equipped with two reinforced concrete cutoff collars located upstream and downstream from the control tower. Plate 6 illustrates the details of the outlet works. Flow through the outlet conduit is controlled by a manually operated sluice gate located in the control tower (Plate 7).

c. Design Data

(1) Hydrology and Hydraulics. The 1948 state report indicates that the spillway was designed for a flow of 1110 cubic feet per second (cfs) per square mile of drainage area, which corresponds to a capacity of 15,400 cfs. The report further indicates that the provided spillway capacity was in excess of the spillway design criteria used at the time of the design.

(2) Embankment. Other than design drawings, no engineering data are available on the design of the embankment.

(3) Appurtenant Structures. No design calculations are available for the appurtenant structures.

2.2 Construction. Construction of the dam was apparently conducted in accordance with the drawings and specifications prepared by the design engineer. Very limited information was available on the construction of the dam. The specifications required the embankment to be placed in layers not exceeding 6 inches in loose depth and compacted to 95 percent of Modified Proctor density.

Available information indicates no major postconstruction changes.

2.3 Operation. County personnel reported that there are no formal operating records for this dam.

2.4 Other Investigations. None reported.

2.5 Evaluation

a. Availability. The available information was provided by PennDER and the County of Beaver.

b. Adequacy

(1) Hydrology and Hydraulics. The available information consists of the design discharge capacity of the spillway. This information is not considered to be adequate to assess the conformance of the spillway capacity to the current spillway design criteria.

(2) Embankment. The dam was apparently designed based on the evaluation of the subsurface conditions and borrow materials. References were found to indicate that certain laboratory soil testing was conducted. The design incorporated such basic components as an impervious central core and positive foundation cutoff. However, the design did not incorporate an internal drainage system for the embankment, such as filter blankets or chimney drains.

(3) Appurtenant Structures. Review of the design drawings indicates that as designed no significant design deficiencies existed that would affect the overall performance of the appurtenant structures.

SECTION 3 VISUAL INSPECTION

3.1 Findings

a. General. The on-site inspection of Brady's Run Dam consisted of:

1. Visual inspection of the embankment, abutments, and embankment toe.
2. Visual examination of the spillway and its components, the downstream end of the outlet conduit.
3. Observation of factors affecting runoff potential of the drainage basin.
4. Evaluation of downstream area hazard potential.

The specific observations are illustrated in Plate 8 and in the photographs in Appendix C.

b. Embankment. The general inspection of the embankment consisted of searching for indications of structural distress, such as cracks, subsidence, bulging, wet areas, seeps and boils, and observing general maintenance conditions, vegetative cover, erosion, and other surficial features.

In general, the condition of the dam is considered to be good. Only one seepage area was found, below the toe of the dam near the right abutment. The seepage flow was estimated to be on the order of one gallon per minute. Another seep was found on the left abutment approximately 500 feet downstream from the dam. The flow was estimated to be on the order of 5 to 10 gallons per minute. It appeared that the probable source of this seep is a spring from the hillside rather than seepage through the dam.

The portion of the embankment adjacent to the spillway retaining walls was found to have settled. This settlement appears to be related to tilting and displacement of the adjacent retaining walls. This settled area is approximately 10 to 15 feet wide and starts from the upstream face of the dam and continues over the crest and partially downstream. The top of the dam was surveyed relative to the spillway crest elevation and the settled area adjacent to the spillway wall was found to be 0.8 foot below the design freeboard level. The second low area was found adjacent to the right abutment and was 0.2 foot below the design crest level. The remainder of the crest was 0.2 to 0.9 foot above the design freeboard level.

c. Appurtenant Structures. The appurtenant structures were examined for deterioration or other signs of distress and obstructions that would limit flow. In general, the visible portions of the spillway and the outlet works are considered to be in fair condition. Two structural cracks were observed at the construction joint of the right spillway walls. At the construction joint upstream from the spillway control section, the adjacent panels of the wall have separated and moved horizontally approximately one inch relative to each other.

Beaver County personnel reported that, to their knowledge, the outlet conduit sluice gate has not been operated since the construction of the dam. The control tower access hatch has apparently jammed and could not be opened. Therefore, the operating equipment inside the control tower could not be observed.

d. Reservoir Area. A map review indicates that the watershed is predominantly covered by woods and pasturelands. Several rural residential areas are scattered throughout the watershed. A review of the regional geology (Appendix E) indicates that the shorelines of the reservoir are likely to be susceptible to landslides. However, massive landslides which would affect the storage volume of the reservoir are considered to be unlikely.

e. Downstream Channel. Downstream from the dam, the South Branch of Brady's Run flows approximately one mile east where it joins Brady's Run. Brady's Run in turn flows south for about three miles and discharges into Beaver River about one mile north of Beaver, Pennsylvania. There are in excess of 100 residential, commercial, and industrial buildings along the course of Brady's Run.

3.2 Evaluation. The condition of the dam is considered to be good. However, the structural cracks on the spillway walls should be repaired to avoid further structural damage to the retaining walls. The crest of the dam should be surveyed and low sections should be filled to design elevation. The erosion ditches on both sides of the spillway discharge channel should also be filled. The operational condition of the outlet works sluice gate should be evaluated and necessary maintenance performed.

SECTION 4 OPERATIONAL FEATURES

4.1 Procedure. There are no formal operating procedures for the dam. The reservoir is normally maintained at the spillway crest level with excess inflow discharging over the uncontrolled spillway.

4.2 Maintenance of the Dam. The maintenance condition of the dam is considered to be fair. Although it appears that the brush and trees on the downstream face of the dam have been recently cleared, no attempts were made to fill the erosion ditches and the low spots on the embankment. County personnel reported that there is no full-time dam tender responsible for the maintenance and operation of the dam. The dam is maintained by county personnel on an as-needed basis.

4.3 Maintenance of Operating Facilities. The maintenance condition of the operating facilities is considered to be poor. County personnel reported that, to their best knowledge, the outlet conduit sluice gate has not been operated since the construction of the dam. The access hatch on the control tower has apparently rusted and jammed and could not be opened. Therefore, the condition of the operating equipment in the control tower could not be observed.

4.4 Warning System. No formal warning system exists for the dam. Telephone communication facilities are available in the vicinity of the site.

4.5 Evaluation. While the overall maintenance condition of the dam is considered to be fair, the condition of the operating facilities is assessed to be poor. The operational condition of the outlet works sluice gate should be evaluated and necessary maintenance performed. The low spot on the embankment and the erosion ditches on each side of the spillway should also be filled.

SECTION 5 HYDRAULICS AND HYDROLOGY

5.1 Evaluation of Features

a. Design Data. Brady's Run Dam has a watershed of 13.8 square miles and impounds a reservoir with a surface area of 27.6 acres at normal pool level. The combined primary and emergency spillway is located on the left abutment. The capacity of the spillway is reported to be 15,400 cfs with no freeboard.

b. Experience Data. As previously stated, Brady's Run Dam is classified as a small dam in the high hazard category. Under the recommended criteria for evaluating emergency spillway discharge capacity, such impoundments are required to pass half to full PMF.

The PMF inflow hydrograph for the reservoir was determined utilizing the Dam Safety Version of the HEC-1 computer program developed by the Hydrologic Center of the U.S. Army, Corps of Engineers. Data used for the computer analysis are presented in Appendix D. The PMF inflow hydrograph was found to have a peak flow of 11,701 cfs. The computer input and the summary of computer output are also included in Appendix D.

c. Visual Observations. On the date of inspection, no conditions were observed that would indicate that the spillway capacity would be significantly reduced in the event of a flood.

d. Overtopping Potential. Various percentages of PMF inflow hydrograph were routed through the reservoir, and it was found that the spillway can pass 100 percent PMF at a maximum pool level of Elevation 836.04, leaving about one foot of freeboard to the low spot on the crest of the embankment. Stage versus storage capacity data for the lake were obtained from original design data.

e. Spillway Adequacy. The spillway capacity (100 percent PMF) is classified to be adequate according to the recommended criteria.

SECTION 6 STRUCTURAL STABILITY

6.1 Evaluation of Structural Stability

a. Visual Observations

(1) Embankment. As discussed in Section 3, the field observations did not reveal any signs of distress that would significantly affect the performance of the structure, and no unsatisfactory conditions were reported in the past. Since the design lacks a positive internal drainage system, some concern exists as to the location of the phreatic surface to the embankment as it affects the stability of the embankment. However, at the present time, the downstream slope and the toe area of the dam are firm, indicating that the phreatic surface does not intersect the downstream slope of the dam.

(2) Appurtenant Structures. Presence of structural cracks on the right spillway walls and associated settlement of the embankment behind the wall raises some concern as to the continued stability of these walls. It is considered that remedial work should be performed to avoid further structural distress to these walls.

b. Design and Construction Data

(1) Embankment. The dam was apparently designed based on the evaluation of subsurface conditions and borrow materials. Although references were found to indicate certain laboratory tests were conducted, no references were found to indicate whether seepage or stability analyses were performed. Apparently, the dam was constructed under the supervision of the design engineer's field representative.

Review of the available information indicates that the dam was constructed with reasonable care and design incorporated such basic elements as a central impervious core and a positive cutoff wall extending to top of rock. However, it was noted that the design did not include a positive internal drainage system.

(2) Appurtenant Structures. Other than design drawings, no design and construction data were available for the appurtenant structures.

c. Operating Records. The structural stability of the dam is not considered to be affected by the operational features of the dam.

d. Post-Construction Changes. None reported.

e. Seismic Stability. The dam is located in Seismic Zone 1, and based on visual observations, the static stability of the dam is considered to be adequate. Therefore, based on the recommended criteria for evaluation of seismic stability of dams, the structure is presumed to present no hazard from earthquakes.

SECTION 7
ASSESSMENT AND RECOMMENDATIONS/PROPOSED REMEDIAL MEASURES

7.1 Dam Assessment

a. Assessment. The visual observations indicate that Brady's Run Dam is in good condition. No conditions were observed that would significantly affect the overall performance of the structure at this time and none were reported in the past. To the extent that can be determined, it appears that the dam was constructed with reasonable care.

The presence of two structural cracks in the right spillway wall and associated settlement of the embankment behind the walls raises some concern as to the continued stability of these structures. Necessary remedial work should be performed to avoid further structural distress and to insure continued stability of these structures.

The capacity of the spillway (100 percent PMF) was found to be adequate according to the recommended criteria.

b. Adequacy of Information. Available information in conjunction with visual observations and previous experience of the inspectors are considered to be sufficient to make a reasonable assessment of the condition of the dam.

c. Urgency. The following recommendations should be implemented as soon as possible or on a continuing basis.

d. Necessity for Additional Data. No additional data are considered required at this time.

7.2 Recommendations/Remedial Measures. It is recommended that:

1. Necessary remedial work should be performed on the right spillway wall to avoid further structural distress and to insure continued stability of these structures.
2. Operational condition of the outlet works sluice gate should be evaluated and necessary maintenance performed.
3. Low spots on the embankment and erosion ditches on each side of the spillway chute should be filled.
4. Around-the-clock surveillance should be provided during unusually heavy runoff and a formal

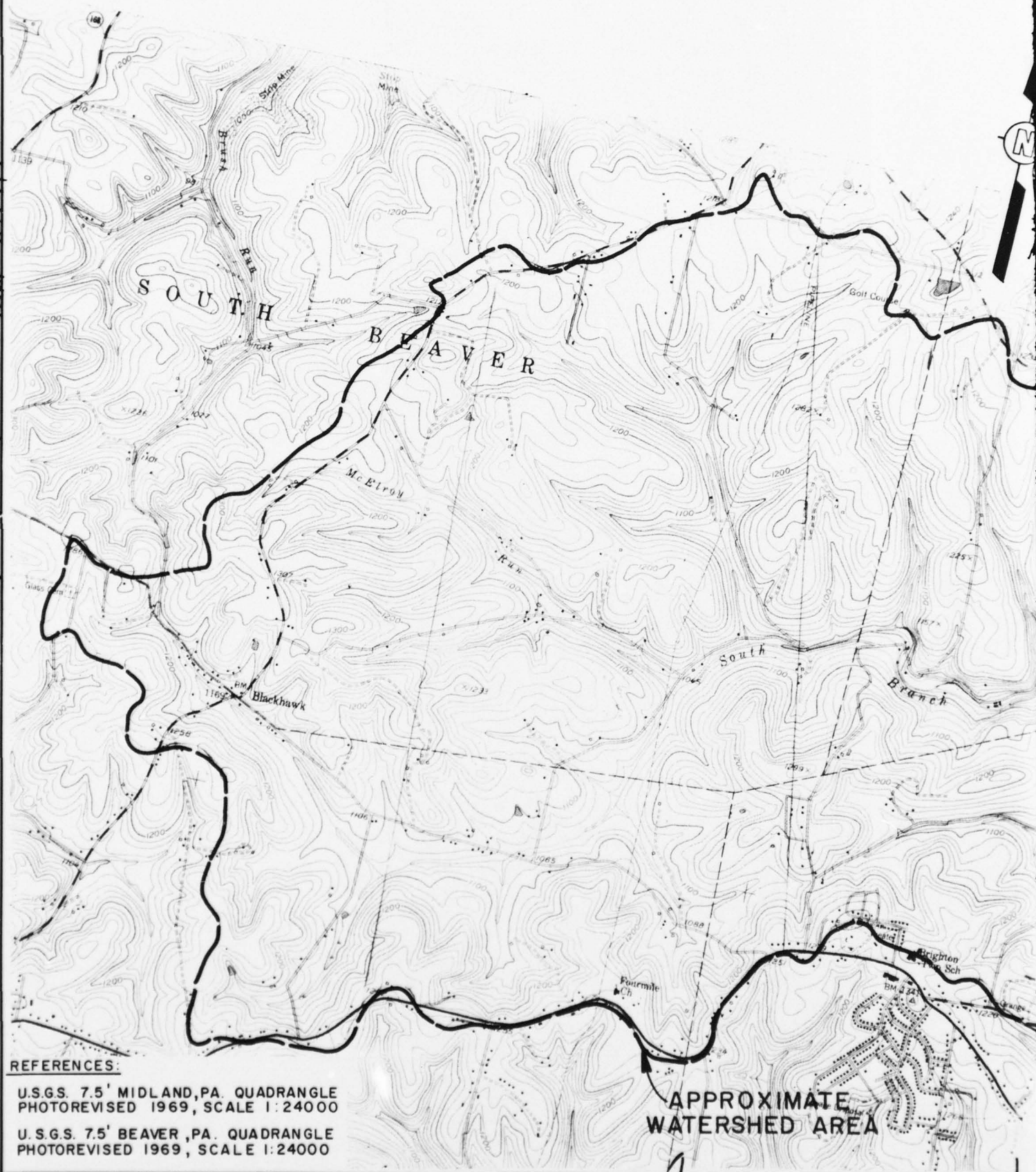
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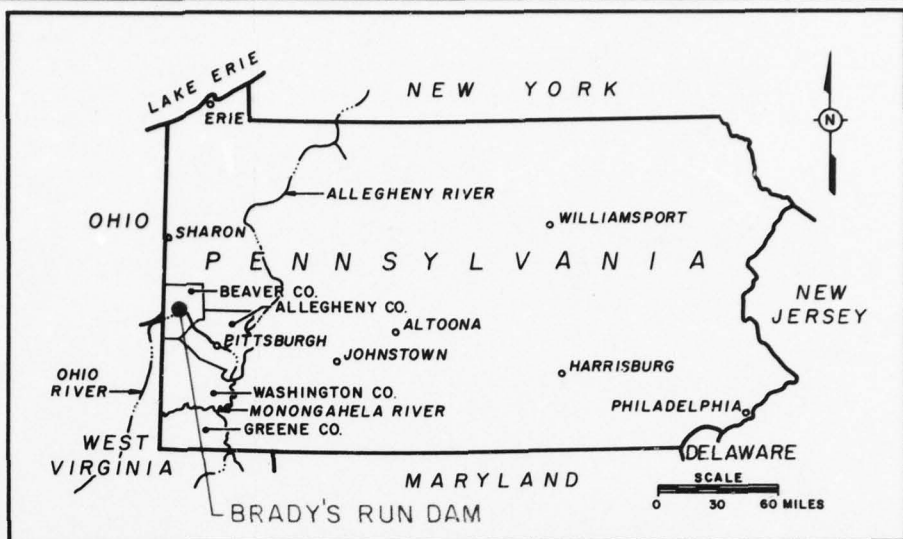
warning system should be developed to alert the downstream residents in the event of emergencies.

5. The trees and brush should be removed from the spillway discharge channel.
6. The wet area on the embankment and the seepage points should be periodically observed to document if the conditions are changing.
7. The dam and appurtenant structures should be inspected regularly and necessary maintenance performed.

PLATES

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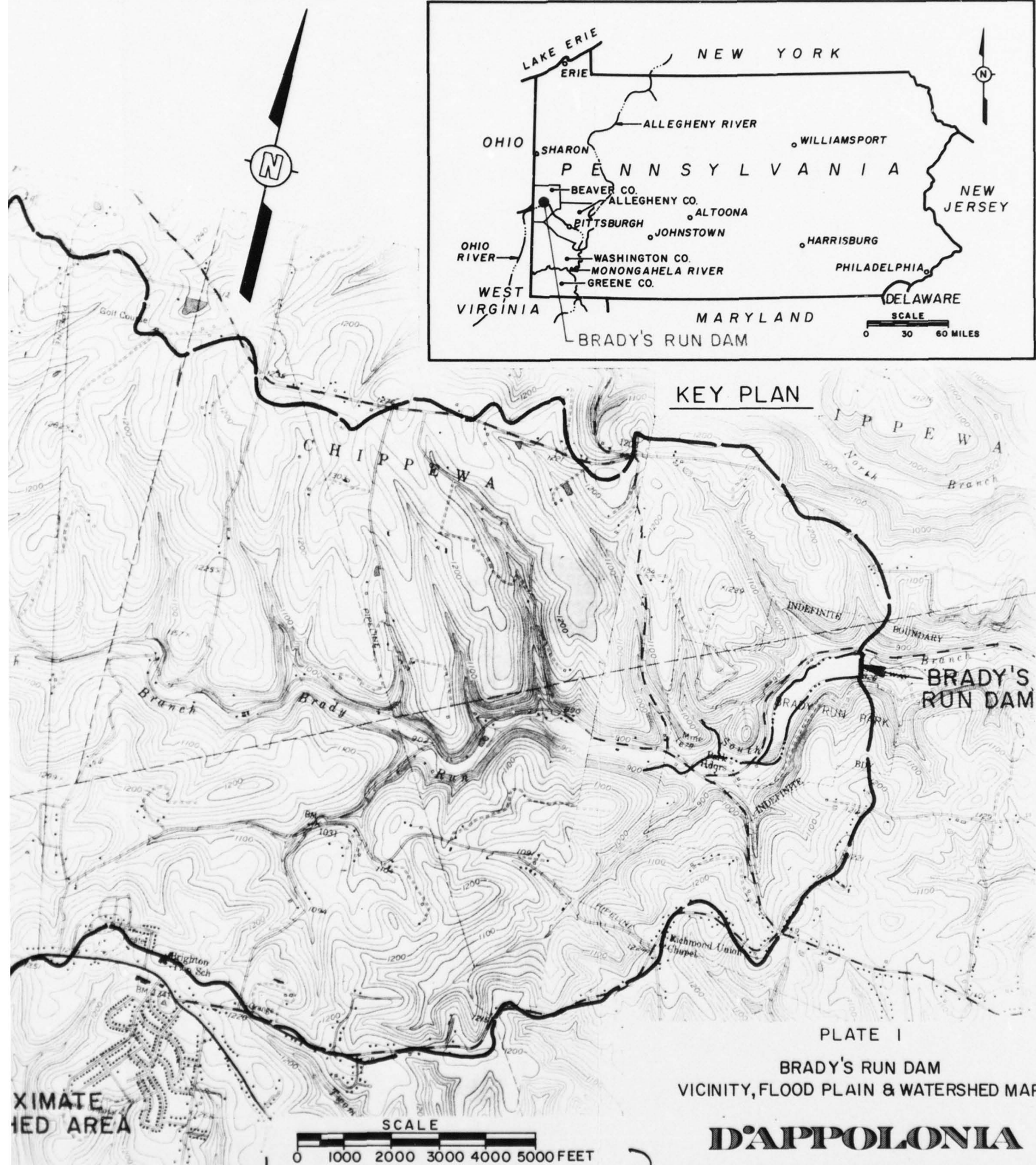


PLATE I

BRADY'S RUN DAM
VICINITY, FLOOD PLAIN & WATERSHED MAP

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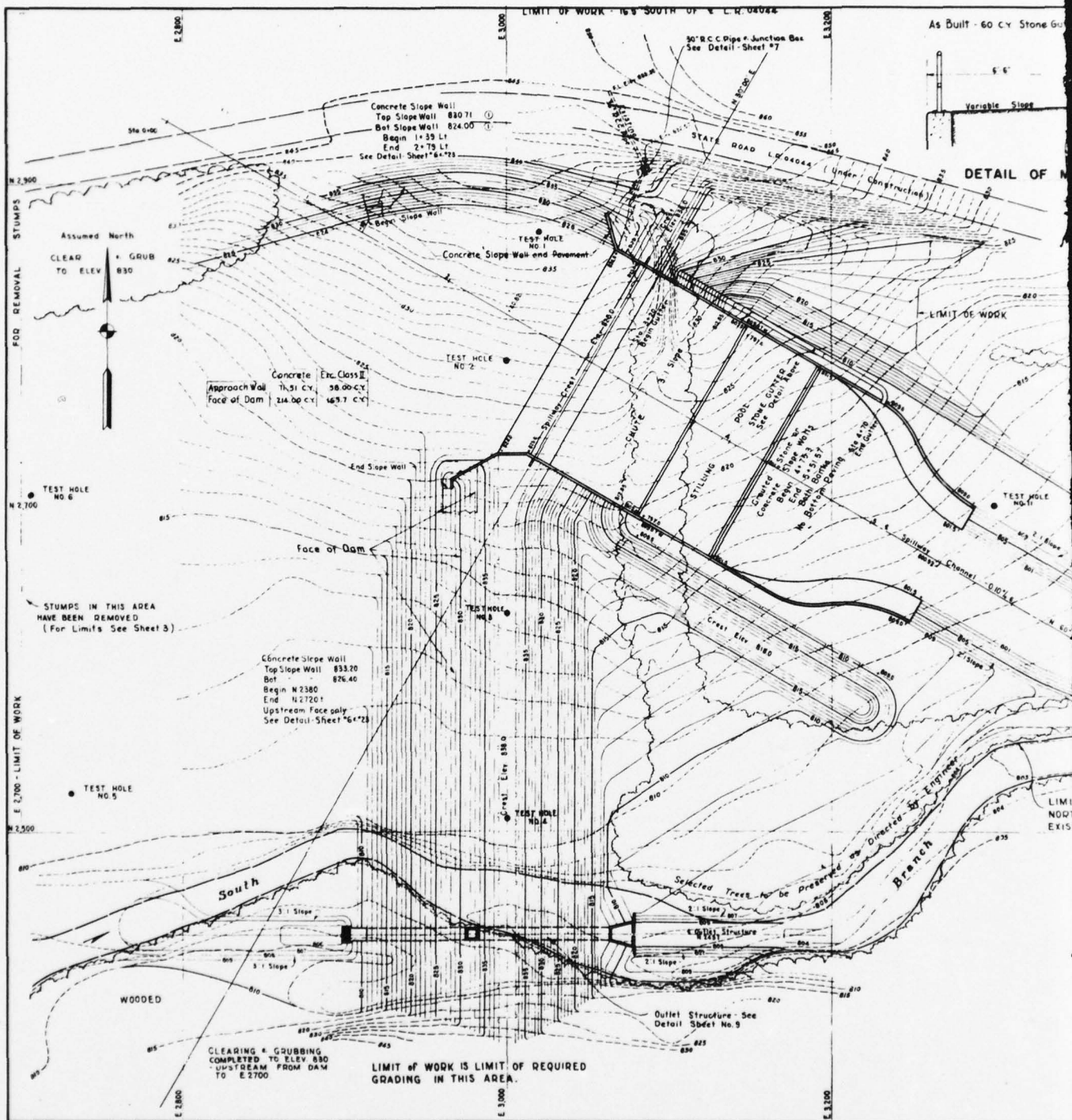
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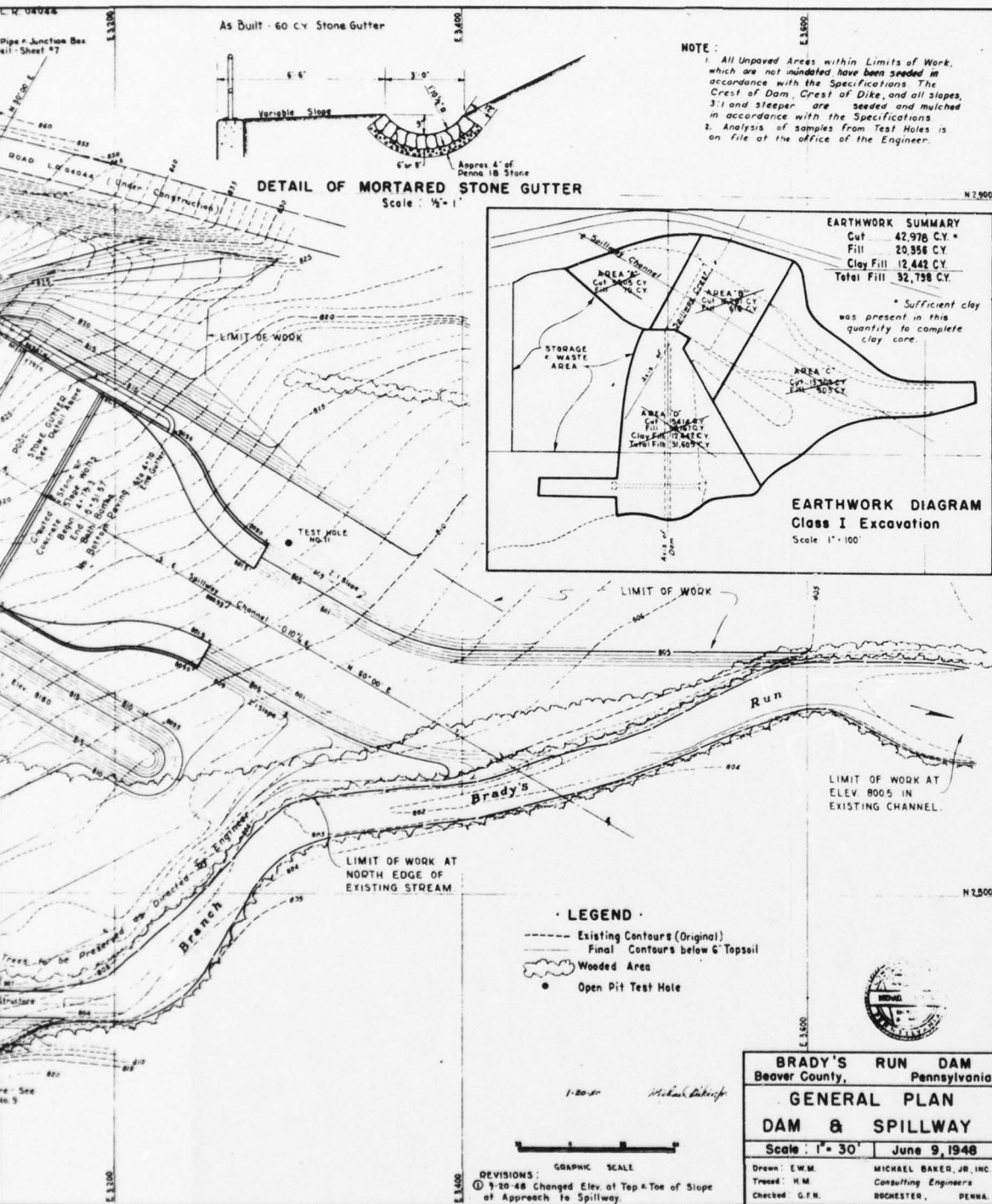
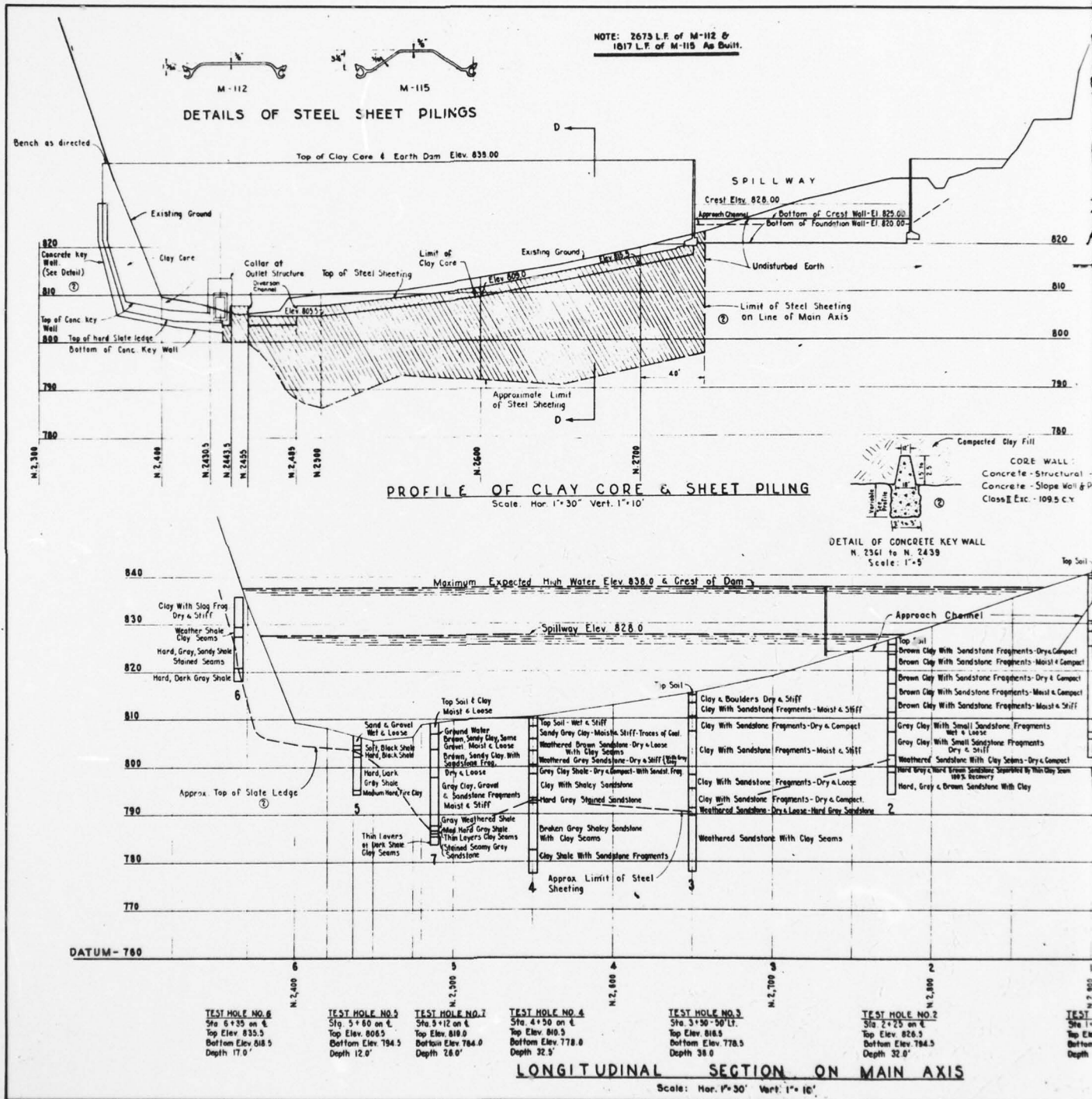


PLATE 2

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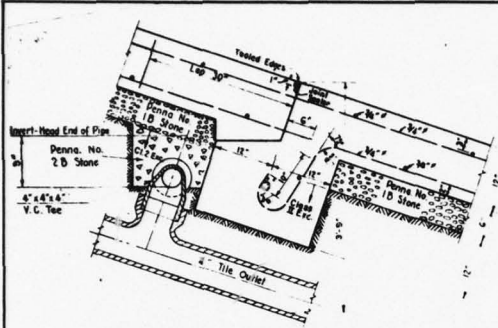
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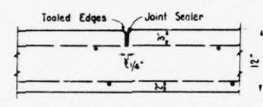


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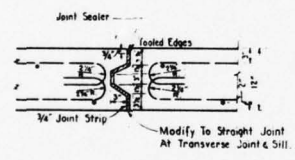
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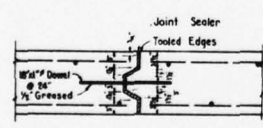
TRANSVERSE JOINT & SILL "T-T"
 Scale: none



WEAKENED PLANE JOINT "W-W"
 Scale: 1"=1'



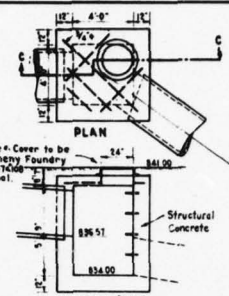
EXPANSION JOINT (T & G) "C-C"
 Scale: 1"=1'



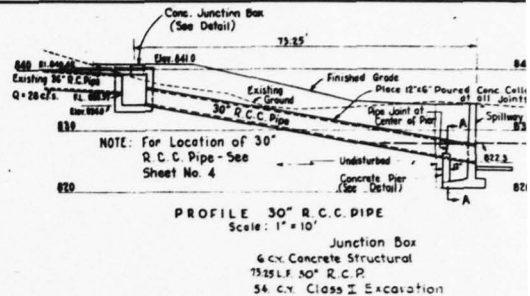
STILLING POOL EXPANSION JOINT "S-S"
 Scale: 1"=1'

LIST OF QUANTITIES

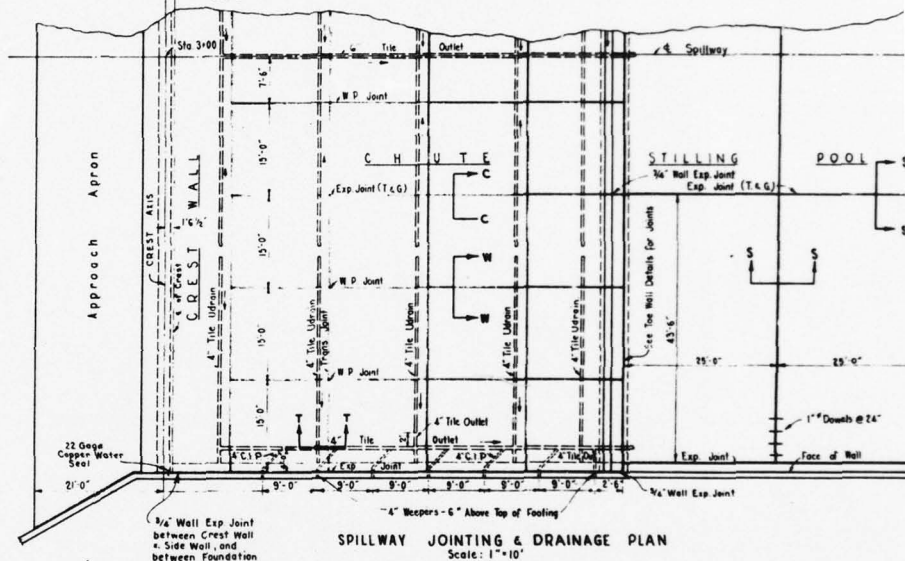
	CONCRETE C.Y.	STEEL LBS.	CLASS II E.C. C.Y.	Grout Stone Part C.Y.
Approach Apron	70	1276	71.0	
Crest Wall	156	1448	18.0	
Found. Wall	50	246	48.0	
Chute Slab & Sills	389	26185	48.0	
Toe Wall	139	1732	90.0	
Pool Slab	244	31264		350
Baffle Wall	110	246	140.0	
GRAND TOTAL	1158	3210	421.0	
ALTERNATE TOTAL		3210 - 31500		



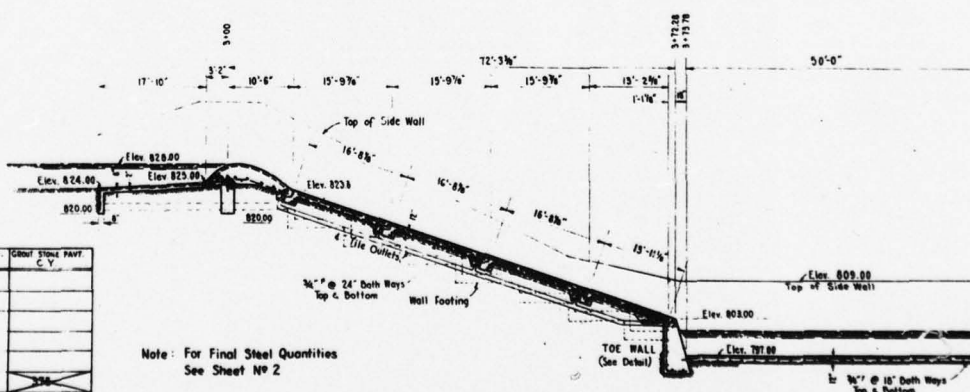
SECTION "C-C"
 CONCRETE JUNCTION BOX
 Scale: 1"=4'



PROFILE 30" R.C.C. PIPE
 Scale: 1"=10'
 Junction Box
 4" x Concrete Structural
 73.25 L.F. 30" R.C.P.
 54 C.Y. Class II Excavation



SPILLWAY JOINTING & DRAINAGE PLAN
 Scale: 1"=10'



SECTION OF SPILLWAY
 Scale: 1"=10'

Note: For Final Steel Quantities
 See Sheet No 2

DRAWING 78-367-B101
NUMBER 4-17-79

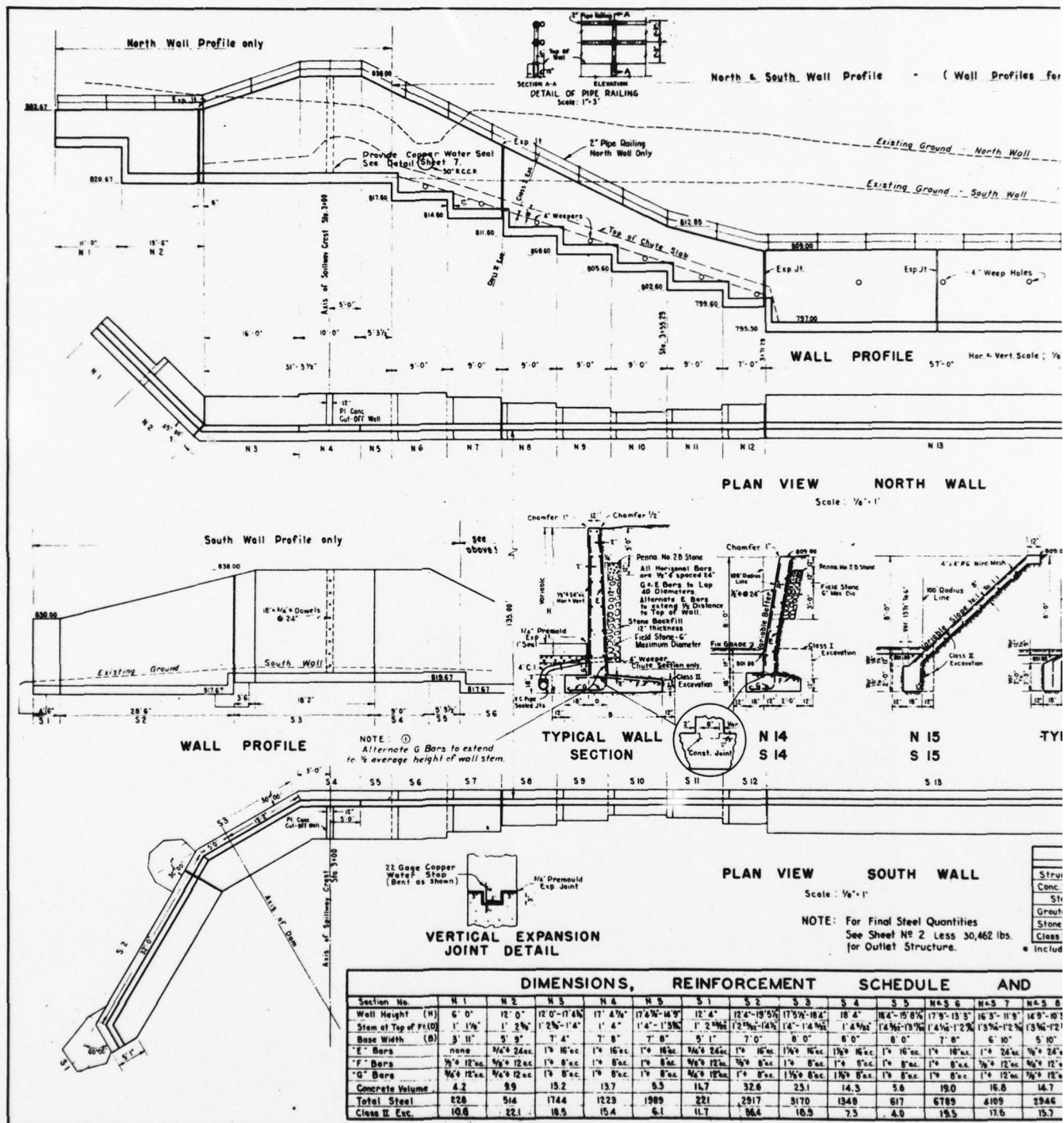
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APPROVED BY

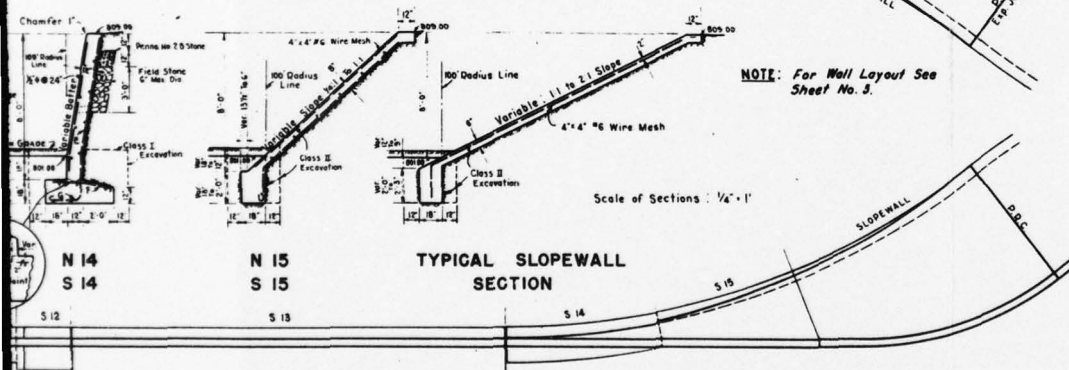
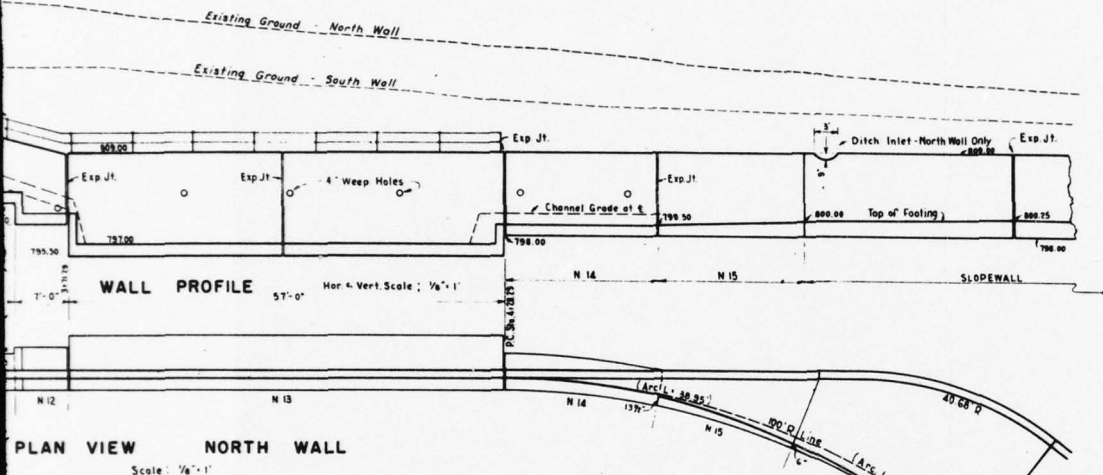
ACS

1-4-79

DRAWN BY



North & South Wall Profile - (Wall Profiles for this section of North & South Walls are identical)



PLAN VIEW SOUTH WALL

Scale: 1/4" = 1'

NOTE: For Final Steel Quantities See Sheet No 2 Less 30,462 lbs. for Outlet Structure.

SUMMARY OF QUANTITIES			
	RAIL	QUANTITY	ESTIMATE QUANTITY
Struct Conc.	382	C.Y.	310 C.Y.
Conc Slopewall	89	C.Y.	40 C.Y.
Steel	22,045	LBS.	22,045 LBS.
Grouted Stone	50.92	C.Y.	28 C.Y.
Stone Backfill	491	C.Y.	430 C.Y.

* Includes Quantities to End of Slope Walls at Sta 5+51.57 - As Built 140.8 C.Y. CLASS II Exc.

REVISIONS:
① 9-20-48 Typical Wall Section - Note added revising G Bars.



ORCEMENT SCHEDULE AND QUANTITIES														
S. 2	S. 3	S. 4	S. 5	N.S. 6	N.S. 7	N.S. 8	N.S. 9	N.S. 10	N.S. 11	N.S. 12	N.S. 13	N.S. 14	N.S. 15	N.S. 16
12'-4" - 19'-3"	17'-3" - 18'-4"	18'-4" - 19'-3"	19'-3" - 20'-4"	20'-4" - 21'-5"	21'-5" - 22'-6"	22'-6" - 23'-7"	23'-7" - 24'-8"	24'-8" - 25'-9"	25'-9" - 26'-10"	26'-10" - 27'-11"	27'-11" - 28'-12"	28'-12" - 29'-13"	29'-13" - 30'-14"	30'-14" - 31'-15"
12'-4" - 19'-3"	17'-3" - 18'-4"	18'-4" - 19'-3"	19'-3" - 20'-4"	20'-4" - 21'-5"	21'-5" - 22'-6"	22'-6" - 23'-7"	23'-7" - 24'-8"	24'-8" - 25'-9"	25'-9" - 26'-10"	26'-10" - 27'-11"	27'-11" - 28'-12"	28'-12" - 29'-13"	29'-13" - 30'-14"	30'-14" - 31'-15"
7'-0"	8'-0"	9'-0"	10'-0"	11'-0"	12'-0"	13'-0"	14'-0"	15'-0"	16'-0"	17'-0"	18'-0"	19'-0"	20'-0"	21'-0"
1'-0" 16' 16' 16' 16' 16' 16' 16' 16' 16' 16' 16' 16' 16' 16' 16'	1'-0" 16' 16' 16' 16' 16' 16' 16' 16' 16' 16' 16' 16' 16' 16'	1'-0" 16' 16' 16' 16' 16' 16' 16' 16' 16' 16' 16' 16' 16' 16'	1'-0" 16' 16' 16' 16' 16' 16' 16' 16' 16' 16' 16' 16' 16' 16'	1'-0" 16' 16' 16' 16' 16' 16' 16' 16' 16' 16' 16' 16' 16' 16'	1'-0" 16' 16' 16' 16' 16' 16' 16' 16' 16' 16' 16' 16' 16' 16'	1'-0" 16' 16' 16' 16' 16' 16' 16' 16' 16' 16' 16' 16' 16' 16'	1'-0" 16' 16' 16' 16' 16' 16' 16' 16' 16' 16' 16' 16' 16' 16'	1'-0" 16' 16' 16' 16' 16' 16' 16' 16' 16' 16' 16' 16' 16' 16'	1'-0" 16' 16' 16' 16' 16' 16' 16' 16' 16' 16' 16' 16' 16' 16'	1'-0" 16' 16' 16' 16' 16' 16' 16' 16' 16' 16' 16' 16' 16' 16'	1'-0" 16' 16' 16' 16' 16' 16' 16' 16' 16' 16' 16' 16' 16' 16'	1'-0" 16' 16' 16' 16' 16' 16' 16' 16' 16' 16' 16' 16' 16' 16'	1'-0" 16' 16' 16' 16' 16' 16' 16' 16' 16' 16' 16' 16' 16' 16'	1'-0" 16' 16' 16' 16' 16' 16' 16' 16' 16' 16' 16' 16' 16' 16'
32.6	23.1	14.3	5.6	19.0	16.8	14.7	12.5	10.4	8.3	6.2	4.1	2.0	0.9	0.8
2917	3170	1349	617	6789	4109	2946	1906	1574	1208	2016	6168	791	545	300
36.4	18.3	7.3	4.0	19.5	17.6	15.7	14.2	12.4	10.6	8.7	6.8	4.9	3.0	2.6

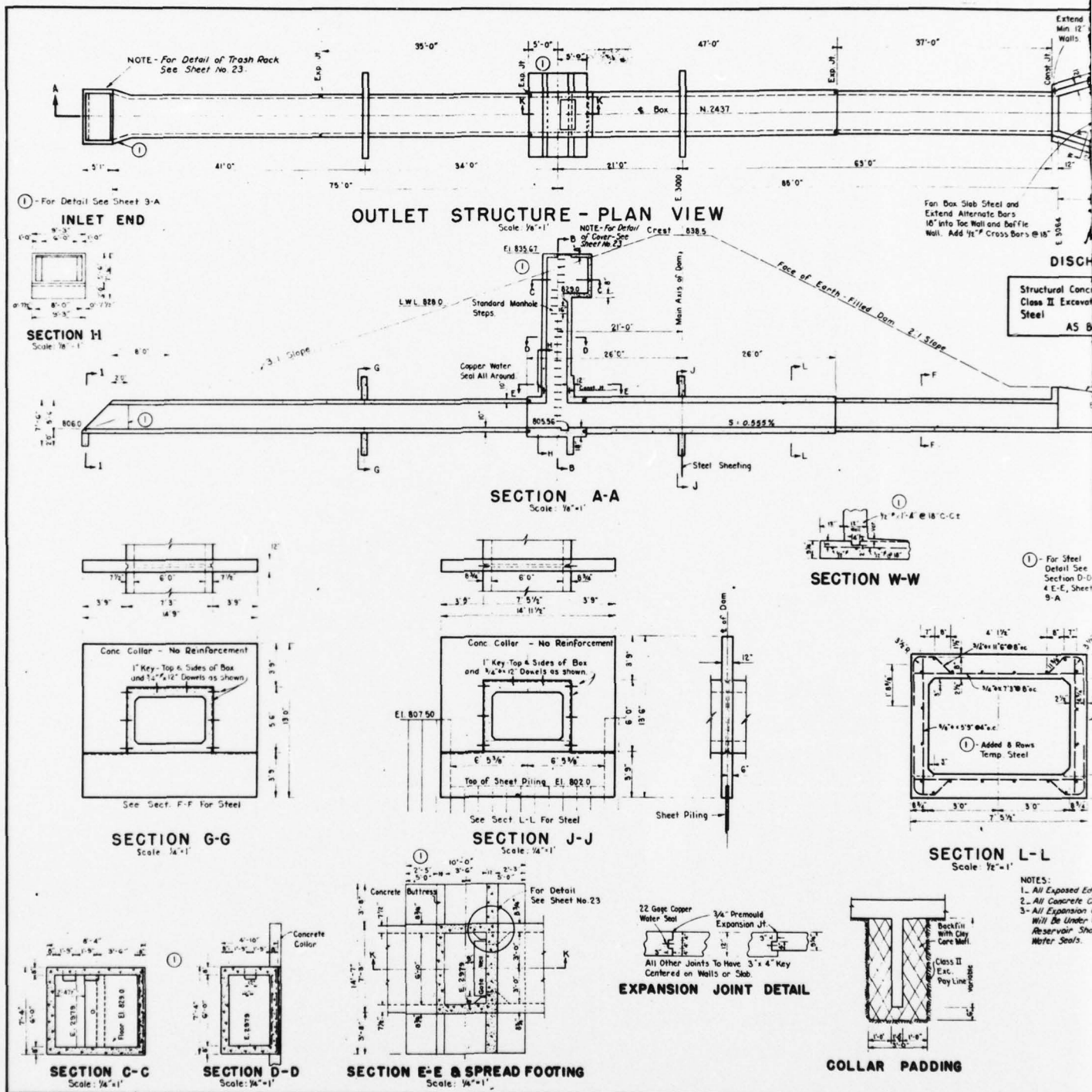
BRADY'S RUN DAM
Beaver County, Pennsylvania

SPILLWAY DETAILS

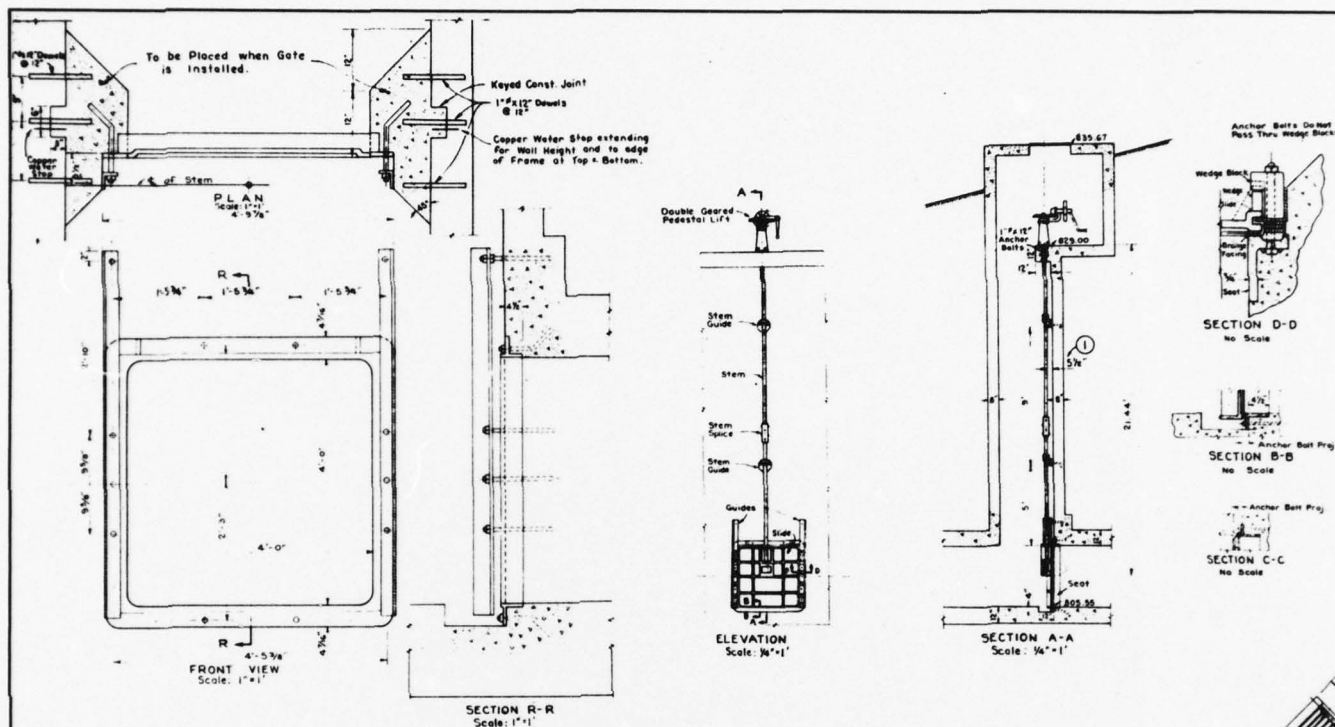
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Drawn: G.F.M.
Traced: R.A.M.
Checked: F.C.

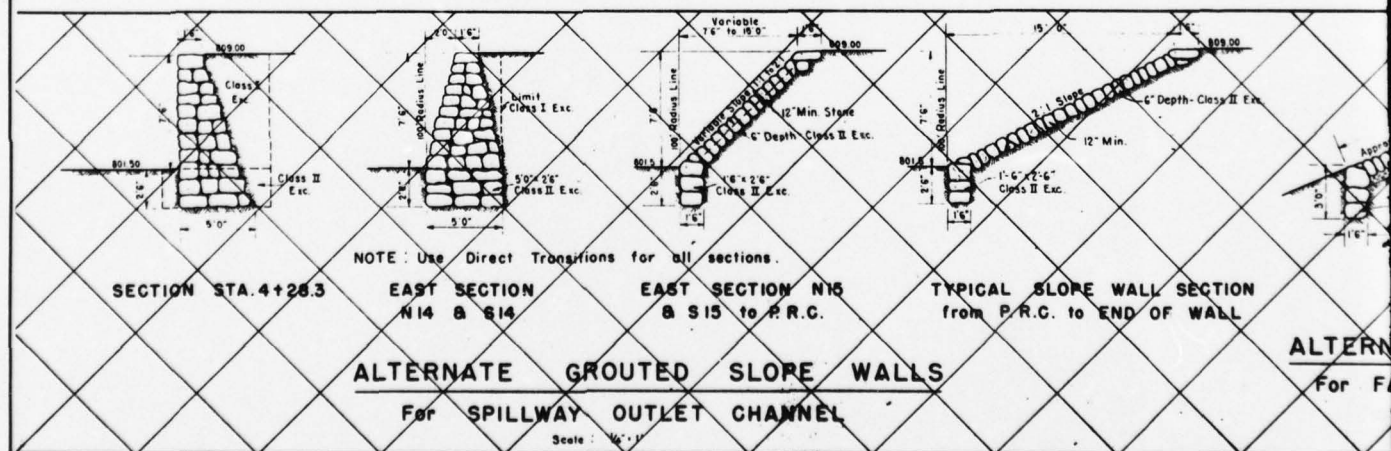
MICHAEL BAKER, JR., INC.
Consulting Engineers
ROCHESTER, PENNA.



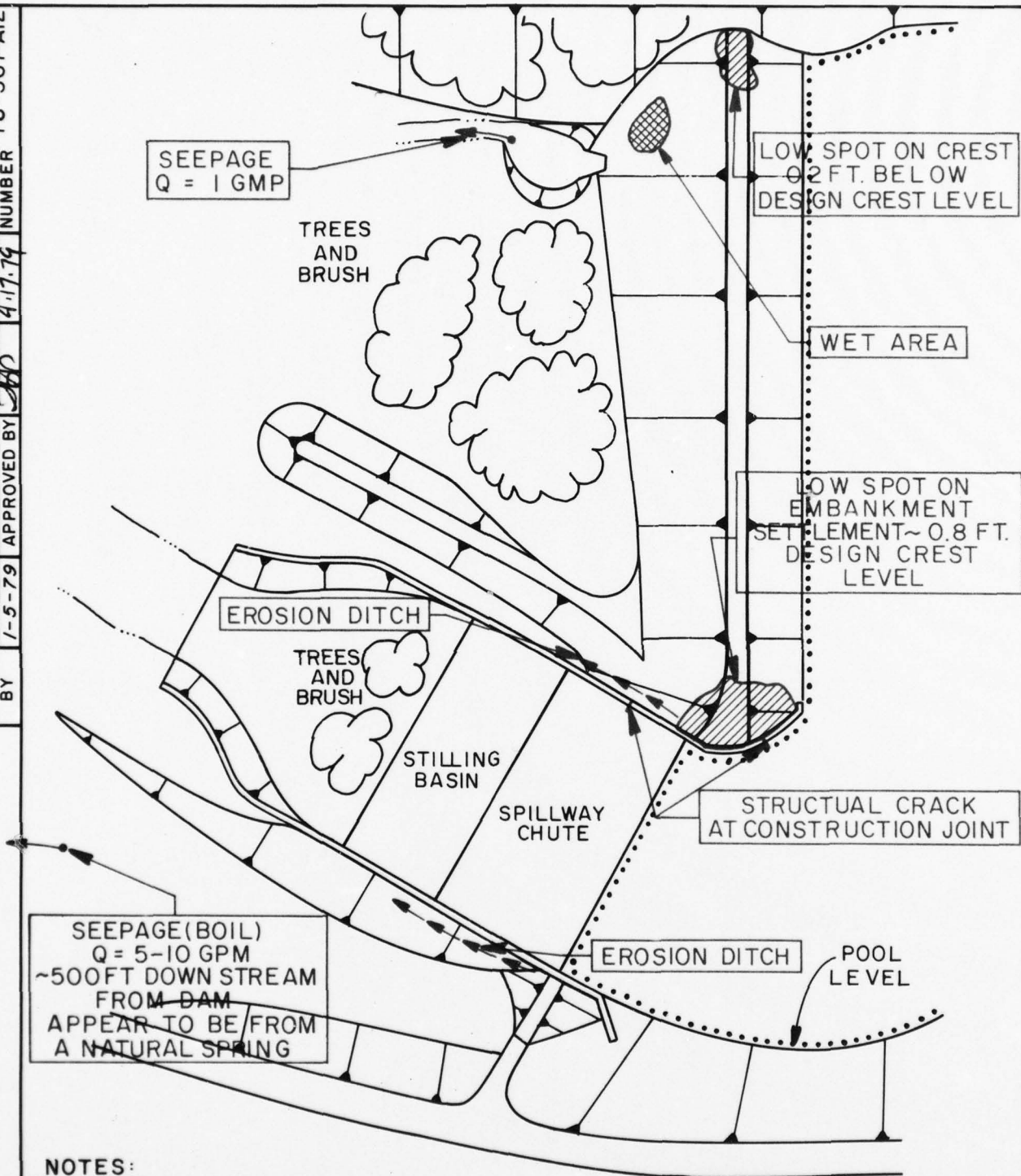
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STEEL OUTLET GATE



DRAWN BY	RDB	CHECKED BY	BE	4-17-79	DRAWING NUMBER
				4-17-79	78-367-A12



NOTES:

1. SPILLWAY FREEBOARD
(MEASURED FROM LOWSPOT
ON CREST) = 9.0 FEET.
2. POOL LEVEL DATE OF
INSPECTION: 0.2 FEET
ABOVE SPILLWAY CREST.

PLATE 8

BRADYS RUN DAM GENERAL PLAN

FIELD INSPECTION NOTES

FIELD INSPECTION DATE: DEC. 13-14, 1978

D'APPOLONIA

APPENDIX A
CHECKLIST
VISUAL INSPECTION
PHASE I

APPENDIX A

CHECKLIST
VISUAL INSPECTION
PHASE I

NAME OF DAM Brady's Run Dam
TYPE OF DAM Earth
DATE(S) INSPECTION December 14, 1978
POOL ELEVATION AT TIME OF INSPECTION 828.2 M.S.L.
INSPECTION PERSONNEL:
Bilgin Erel
Wah-Tak Chan
B. Erel

COUNTY Beaver
STATE Pennsylvania
HAZARD CATEGORY High
WEATHER Partly Cloudy
TEMPERATURE 30s

ID# NDI I.D. NO. PA-257
DER I.D. NO. 4-35

TAILWATER AT TIME OF INSPECTION 806+ M.S.L.

REVIEW INSPECTION PERSONNEL:
(April 16, 1979)
L. D. Andersen
J. H. Pocillot
B. Erel

Bilgin Erel RECORDER

VISUAL INSPECTION
PHASE I
EMBANKMENT

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SURFACE CRACKS	None.	
UNUSUAL MOVEMENT OR CRACKING AT OR BEYOND THE TOE	None.	
SLOUCHING OR EROSION OF EMBANKMENT AND ABUTMENT SLOPES	Two erosion ditches on each side of the spillway chute.	The erosion ditches should be filled.
VERTICAL AND HORIZONTAL ALIGNMENT OF THE CREST	A 10- to 15-foot-wide section of the embankment adjacent to the spillway wall is 0.8 foot below design crest elevation.	The crest of the dam should be surveyed and low spots filled to design elevation.
RIPRAP FAILURES	The upstream slope is protected by cast-in-place concrete slabs. Slabs are in good condition.	

VISUAL INSPECTION
PHASE I
EMBANKMENT

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
JUNCTION OF EMBANKMENT AND ABUTMENT, SPILLWAY AND DAM	No signs of distress.	
ANY NOTICEABLE SEEPAGE	A minor seepage below the toe of the dam near the right abutment. Flow is approximately one to two gallons per minute.	
STAFF GAGE AND RECORDER	None.	
DRAINS	None.	

VISUAL INSPECTION
PHASE I
OUTLET WORKS

VISUAL EXAMINATION OF CRACKING AND SPALLING OF CONCRETE SURFACES IN OUTLET CONDUIT	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
INTAKE STRUCTURE	Visible portions of the outlet works are in good condition.	
OUTLET STRUCTURE	Submerged, not visible.	
OUTLET CHANNEL	In good condition.	
EMERGENCY GATE	No significant obstructions.	
	Reported to be not operated since the construction of the dam. The access hatch at the control tower was jammed and could not be opened. The sluice gate controls in the control tower could not be observed.	The operational condition of the sluice gate should be evaluated and necessary maintenance performed.

VISUAL INSPECTION
PHASE I
UNGATED SPILLWAY

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONCRETE WEIR	In good condition.	
APPROACH CHANNEL	Free of debris and in good condition. There is a structural crack at the construction joint of the right spillway wall approximately 20 feet upstream from the control section.	Necessary maintenance should be performed to avoid further structural distress and to insure continued stability of these walls.
DISCHARGE CHANNEL	Rectangular concrete channel, in good condition. There is a structural crack at the construction joint of the right spillway wall approximately 20 feet downstream from the control section.	Necessary maintenance should be performed to avoid further structural distress and to insure continued stability of these walls.
BRIDGE AND PIERS	None.	

VISUAL INSPECTION
PHASE I
GATED SPILLWAY

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONCRETE SILL	N/A.	
APPROACH CHANNEL	N/A.	
DISCHARGE CHANNEL	N/A.	
BRIDGE PIERS	N/A.	
GATES AND OPERATION EQUIPMENT	N/A.	

VISUAL INSPECTION
PHASE I
INSTRUMENTATION

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
MONUMENTATION/SURVEYS	None.	
OBSERVATION WELLS	None.	
WEIRS	None.	
PIEZOMETERS	None.	
OTHER	None.	

VISUAL INSPECTION
PHASE I
RESERVOIR
OBSERVATIONS

VISUAL EXAMINATION OF	REMARKS OR RECOMMENDATIONS
SLOPES	Steep to moderate.
SEDIMENTATION	Unknown.
UPSTREAM RESERVOIRS	None.

VISUAL INSPECTION
PHASE I
DOWNSTREAM CHANNEL

VISUAL EXAMINATION OF CONDITION (OBSTRUCTIONS, DEBRIS, ETC.)	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
	No apparent obstructions immediately downstream from the dam.	
SLOPES	No apparent instability (immediately downstream from the dam).	
APPROXIMATE NUMBER OF HOMES AND POPULATION	There are numerous houses, commercial and industrial buildings approximately one to three miles downstream from the dam. Population: Approximately 500.	

APPENDIX B
CHECKLIST
ENGINEERING DATA
DESIGN, CONSTRUCTION, OPERATION
AND HYDROLOGIC AND HYDRAULIC
PHASE I

APPENDIX B

CHECKLIST

ENGINEERING DATA

DESIGN, CONSTRUCTION, OPERATION

PHASE I

NAME OF DAM Brady's Run Dam

ID# NDI I.D. NO. PA-257

DER I.D. NO. 4-35

ITEM	REMARKS
AS-BUILT DRAWINGS	The drawings are available in Beaver County files.
REGIONAL VICINITY MAP	See Plate 1.
CONSTRUCTION HISTORY	The dam was designed by Michael Baker, Jr., Inc., of Rochester, Pennsylvania in 1949. The construction of the dam was completed in December 1949.
TYPICAL SECTIONS OF DAM	See Plate 3.
OUTLETS - PLAN - DETAILS - CONSTRAINTS - DISCHARGE RATINGS	See Plates 5, 6, and 7.

CHECKLIST
ENGINEERING DATA
DESIGN, CONSTRUCTION, OPERATION
PHASE I

ITEM	REMARKS
RAINFALL/RESERVOIR RECORDS	Not recorded.
DESIGN REPORTS	None available.
GEOLOGY REPORTS	None available.
DESIGN COMPUTATIONS HYDROLOGY & HYDRAULICS DAM STABILITY SEEPAGE STUDIES	The results of hydrology and hydraulic analyses are included in the 1948 state report. Stability and seepage analyses are not available.
MATERIALS INVESTIGATIONS BORING RECORDS LABORATORY FIELD	See Plate 3 for typical subsurface profile and boring logs.

CHECKLIST
ENGINEERING DATA
DESIGN, CONSTRUCTION, OPERATION
PHASE I

ITEM	REMARKS
POST CONSTRUCTION SURVEYS OF DAM	None reported.
BORROW SOURCES	Unknown.
MONITORING SYSTEMS	None.
MODIFICATIONS	None reported.
HIGH POOL RECORDS	Not recorded.

CHECKLIST
ENGINEERING DATA
DESIGN, CONSTRUCTION, OPERATION
PHASE I

ITEM	REMARKS
POST CONSTRUCTION ENGINEERING STUDIES AND REPORTS	None reported.
PRIOR ACCIDENTS OR FAILURE OF DAM DESCRIPTION REPORTS	None reported.
MAINTENANCE OPERATION RECORDS	Not maintained.
SPILLWAY PLAN SECTIONS DETAILS	See Plates 4 and 5.
OPERATING EQUIPMENT PLANS AND DETAILS	See Plate 7.

CHECKLIST
ENGINEERING DATA
HYDROLOGIC AND HYDRAULIC

DRAINAGE AREA CHARACTERISTICS: 13.8 square miles (woods and pasturelands)

ELEVATION; TOP NORMAL POOL AND STORAGE CAPACITY: 828.0 (233 acre-feet)

ELEVATION; TOP FLOOD CONTROL POOL AND STORAGE CAPACITY: Same as above

ELEVATION; MAXIMUM DESIGN POOL: 838

ELEVATION; TOP DAM: 838 (as designed); 837.2 (measured low spots)

SPILLWAY:

- a. Elevation 828
- b. Type Ogee overflow section
- c. Width 135 feet (perpendicular to flow direction)
- d. Length 100+ feet (length of spillway chute)
- e. Location Spillover Right of spillway
- f. Number and Type of Gates None

OUTLET WORKS:

- a. Type 4-foot by 6-foot reinforced concrete conduit
- b. Location Near right abutment
- c. Entrance Inverts 806.0
- d. Exit Inverts 825.0
- e. Emergency Draindown Facilities Sluice gate

HYDROMETEOROLOGICAL GAGES:

- a. Type None
- b. Location None
- c. Records None

MAXIMUM NONDAMAGING DISCHARGE: Spillway discharge capacity (15,000+ cfs)

APPENDIX C
PHOTOGRAPHS

LIST OF PHOTOGRAPHS
BRADY'S RUN DAM
NDI I.D. NO. PA-257
DECEMBER 14, 1978

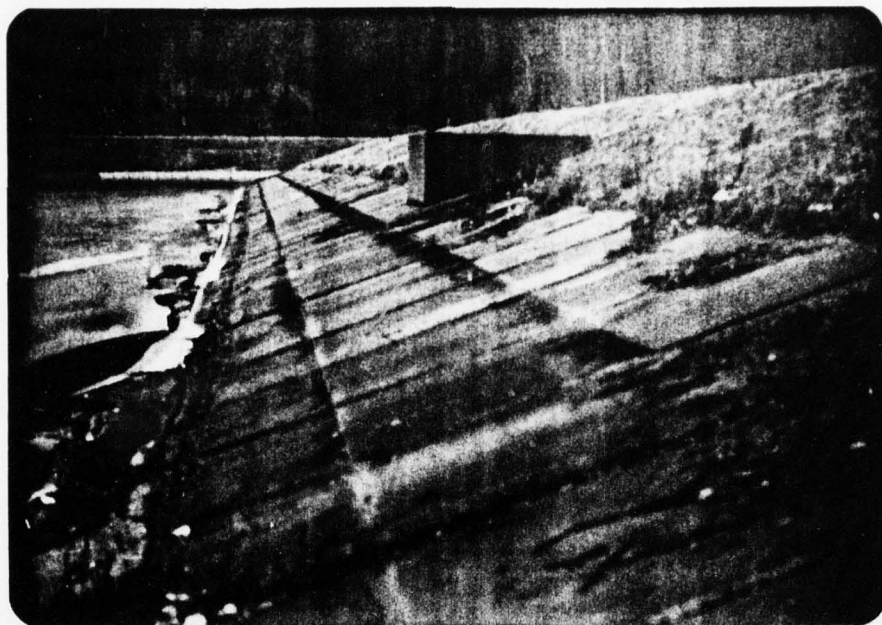
<u>PHOTOGRAPH NO.</u>	<u>DESCRIPTION</u>
1	Crest (looking north).
2	Crest (looking south); spillway in foreground.
3	Upstream slope protection.
4	Spillway.
5	Spillway, plunge pool.
6	Blow-off conduit valve chamber.
7	Blow-off conduit and outlet structure.
8	Potential damage area about 3 miles downstream.



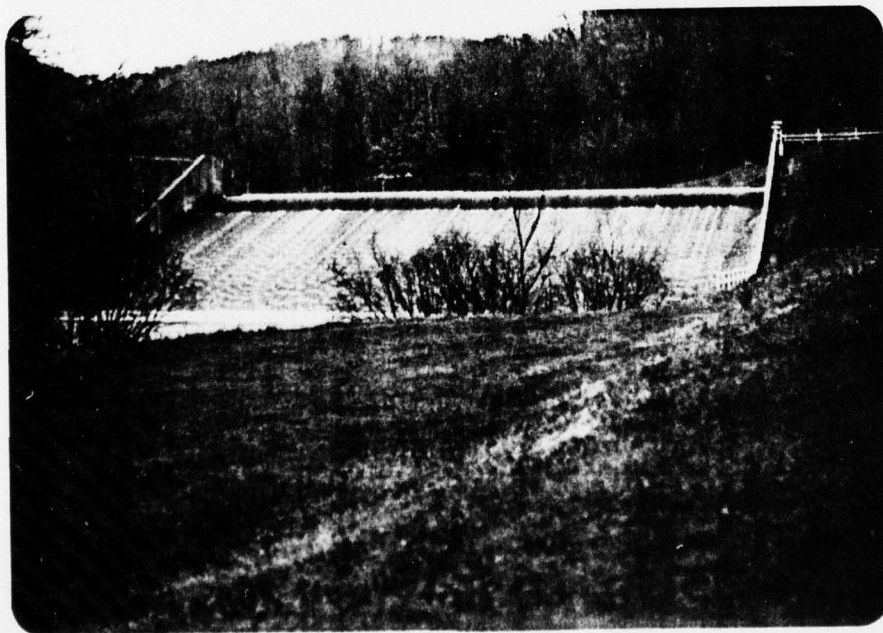
Photograph No. 1
Crest (looking north).



Photograph No. 2
Crest (looking south); spillway in foreground.



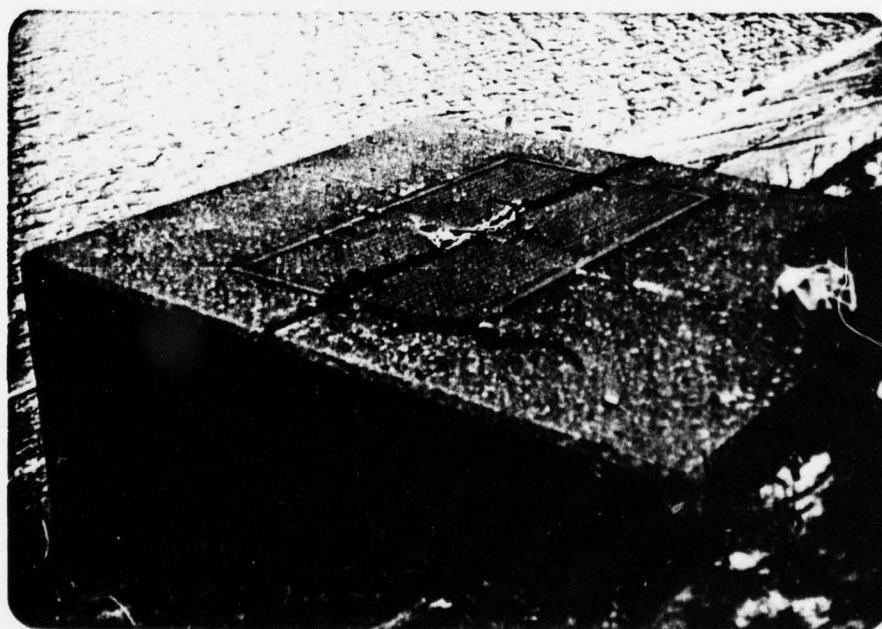
Photograph No. 3
Upstream slope protection.



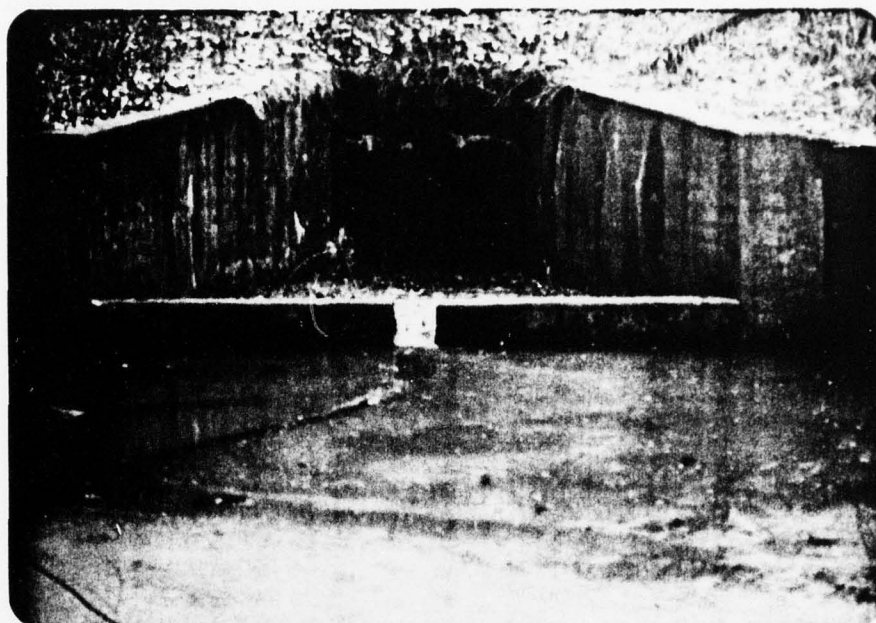
Photograph No. 4
Spillway.



Photograph No. 5
Spillway, plunge pool.



Photograph No. 6
Blow-off conduit valve chamber.



Photograph No. 7
Blow-off conduit and outlet structure.



Photograph No. 8
Potential damage area about 3 miles downstream.

APPENDIX D
CALCULATIONS

HYDROLOGY AND HYDRAULIC ANALYSIS
DATA BASE

NAME OF DAM: Brady's Run Dam (NDI I.D. PA-257)

PROBABLE MAXIMUM PRECIPITATION (PMP) = 24.0 INCHES/24 HOURS⁽¹⁾

STATION	1	2	3	4	5
Station Description	Brady's Run Lake	Brady's Run Dam			
Drainage Area (square miles)	13.8	0			
Cumulative Drainage Area (square miles)	13.8	13.8			
Adjustment of PMP for Drainage Area (%) ⁽²⁾					
6 Hours	99	-			
12 Hours	117	-			
24 Hours	127	-			
48 Hours	137	-			
72 Hours	-	-			
Snyder Hydrograph Parameters					
Zone ⁽³⁾	27	-			
C_p/C_t ⁽⁴⁾	0.40/2.7	-			
L (miles) ⁽⁵⁾	7.4	-			
L_{ca} (miles) ⁽⁵⁾	2.2	-			
$t_p = C_t(L \cdot L_{ca})^{0.3}$ (hours)	6.2	-			
Spillway Data					
Crest Length (ft)	-	135			
Freeboard (ft)	-	9.0			
Discharge Coefficient	-	3.8			
Exponent	-	1.5			

(1) Hydrometeorological Report 33 (Figure 1), U.S. Army, Corps of Engineers, 1956.

(2) Hydrometeorological Report 33 (Figure 2), U.S. Army, Corps of Engineers, 1956.

(3) Hydrological zone defined by Corps of Engineers, Baltimore District, for determining Snyder's Coefficients (C_p and C_t).

(4) Snyder's Coefficients.

(5) L = Length of longest water course from outlet to basin divide.

L_{ca} = Length of water course from outlet to point opposite the centroid of drainage area.

***** FLOOD HYDROGRAPH PACKAGE (HEC-1) DAM SAFETY VERSION LAST MODIFICATION 26 FEB 79 *****									
1	SNYDER UNIT HYDROGRAPH, FLOOD ROUTING	DAM OVERTOPPING ANALYSES							
2	A1	BRADY'S RUN DAM, BEAVER COUNTY, NDI--ID. PA. 257							
3	A2	FOR 20%, 30%, 40%, 50%, 60%, 70%, 80%, 90%, AND 100% PMF							
4	A3								
5	B	300	0	15	0	0	0	0	-4
6	B1	5							
7	J	1	9	0.40	0.50	0.60	0.70	0.80	1.00
8	J1	0.20	0.30						
9	K	0	1						
10	K1	1	13.8	13.8	13.8	13.8	13.8	13.8	13.8
11	M	1	24.0	117	127	137			
12	P	1	2.0						
13	T	6.18	0.40	2.0					
14	X	-1.0	-0.2						
15	K1	1	ROUTING FLOW THROUGH BRADY'S RUN DAM, NDI-ID. PA. 257						
16	Y	1							
17	Y1	1							
18	Y1	1	232.0	537.0	633.5				
19	Y1	1	810.0	828.0	840.0				
20	Y1	1	828.0	840.0	852.0				
21	Y1	1	8637.8	3.080	362.0				
22	Y1	1	10.0	50.0	50.0				
23	Y1	1	837.20	838.65	838.95				
24	Y1	1	837.20	838.65	838.95				
25	Y1	1	837.20	838.65	838.95				

PEAK FLOW AND STORAGE (END OF PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS
 FLOWS IN CUBIC FEET PER SECOND (CUBIC METERS PER SECOND)
 AREA IN SQUARE MILES (SQUARE KILOMETERS)

OPERATION	STATION	AREA	PLAN	RATIOS APPLIED TO FLOWS											
				RATIO 1	RATIO 2	RATIO 3	RATIO 4	RATIO 5	RATIO 6	RATIO 7	RATIO 8	RATIO 9			
HYDROGRAPH AT	1	13.80	1	2340	3510	4680	5850	7021	8191	9361	10531	11701			
	(	35.74)	(	66.27)	(99.40)	(132.53)	(165.67)	(198.80)	(231.93)	(265.07)	(298.20)	(331.33)			
ROUTED TO	2	13.80	1	2332	3501	4671	5840	7011	8181	9351	10521	11691			
	(	35.74)	(	66.04)	(99.13)	(132.25)	(165.38)	(198.52)	(231.65)	(264.78)	(297.92)	(331.05)			

FLOOD ROUTING SUMMARY

PAGE D3 of 4

SUMMARY OF DAM SAFETY ANALYSIS

PLAN 1	ELEVATION STORAGE OUTFLOW	INITIAL VALUE 828.00 233. 0.	SPILLWAY CREST 828.00 233. 0.	TOP OF DAM 837.80 351. 13755.	TIME OF FAILURE HOURS		
	MAXIMUM RESERVOIR W. S. ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
20	830.74	0.00	322	2332	0.00	46.00	0.00
30	831.40	0.00	350	3501	0.00	45.75	0.00
40	832.36	0.00	374	4471	0.00	45.75	0.00
50	833.06	0.00	397	5840	0.00	45.75	0.00
60	833.72	0.00	418	7011	0.00	45.75	0.00
70	834.34	0.00	438	8181	0.00	45.75	0.00
80	834.93	0.00	457	9351	0.00	45.75	0.00
90	835.49	0.00	476	10521	0.00	45.75	0.00
1.00	836.04	0.00	493	11691	0.00	45.75	0.00

OVERTOPPING ANALYSIS SUMMARY

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APPENDIX E
REGIONAL GEOLOGY

APPENDIX E REGIONAL GEOLOGY

Brady's Run Dam is located on strata of the Lower Allegheny Group (Pennsylvanian Age). The geologic structure consists of a series of shallow domes and basins, with the strata in the vicinity of the dam dipping 60 to 80 feet to the southeast.

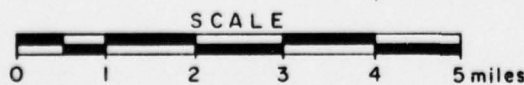
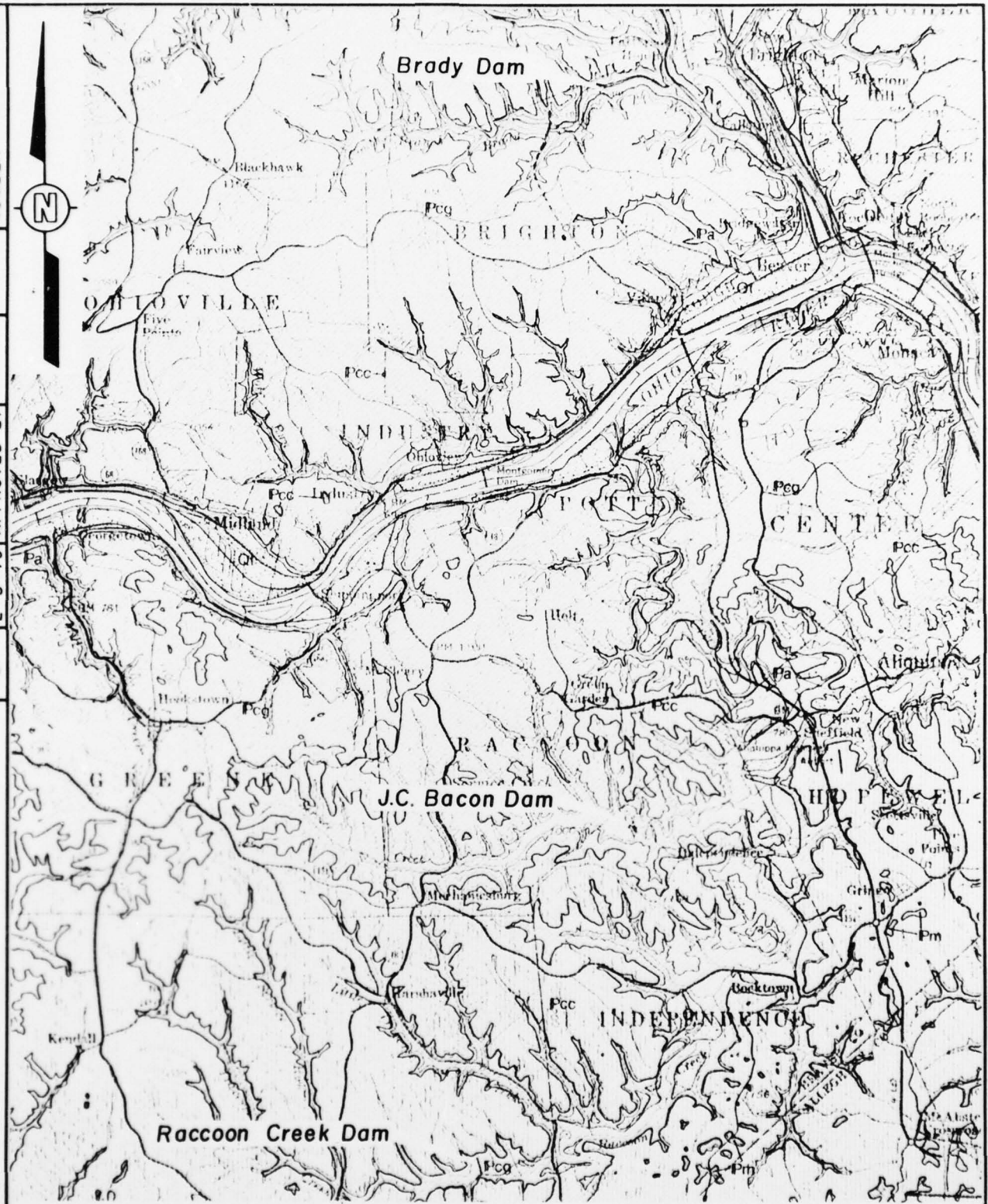
Brady's Run Dam is on strata of the Allegheny Group, consisting primarily of interbedded sandstones, shales, limestone, and coal beds. The dam is approximately 150 feet stratigraphically above the Pottsville Series. The Pottsville Series consist of massive interbedded sandstone and shale seams, while the Allegheny Group also contains interbedded shale and sandstone, with sandstone predominant. There are two massive sandstone beds below the dam: the Bolivar Sandstone and the Clarion Sandstone. In addition, there are three coal seams: the Scrubgrass, Clarion, and Brookville seams (listed in order of increasing depth). The seams have not been mined since the thickness of the seams ranges from 6 to 18 inches. The Vanport Limestone, consisting of limestone and interbedded shale, is 5 to 15 feet thick and occurs in the slopes above the dam and reservoir. The strata below the dam are gray slightly weathered sandstone. Interbedded with the sandstone seams are shale beds which, in many cases, have been weathered to clay.

There does not appear to be any limestone seams below the dam and reservoir which would be susceptible to solutioning. The interbedded shale layers are easily weathered and could be susceptible to erosion. The steep slopes above the reservoir indicate that shallow sliding and slumping may occur. However, the slides should not be large enough to reduce the capacity of the reservoir.

DRAWING 78-307-A21
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BRADY, J.C. BACON AND
RACCOON CREEK DAMS
GEOLOGY MAP

REFERENCE:
GREATER PITTSBURGH REGION GEOLOGIC MAP
COMPILED BY W.R. WAGNER, J.L. CRAFT, L. HEYMAN
AND J.A. HARPER, DATED 1975, SCALE 1:125 000

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 JHP
 2-8-79
 DRAWING NUMBER
 367-A22

GROUP FORMATION

DESCRIPTION

Alluvium		Qt	Sand, gravel, clay.
Terrace deposits			Sand, clay, gravel on terraces above present rivers; includes Carmichaels Formation.
DUNKARD	Greene		Cyclic sequences of sandstone, shale, red beds, thin limestones and coals.
	Washington	Pw	Cyclic sequences of sandstone, shale, limestone, and coal; contains Washington coal bed at base.
	Waynesburg		Cyclic sequences of sandstone, shale, limestone and coal; contains Waynesburg coal bed at base.
MONONGAHELA		Pm	Cyclic sequences of shale, limestone, sandstone and coal; contains Pittsburgh coal bed at base.
P ₃ CONEMAUGH	Casselman	Pcc	Cyclic sequence of sandstone, shale, red beds and thin limestone and coal.
	Ames		
	Glenshaw	Pcg	Cyclic sequences of sandstone, shale, red beds and thin limestone and coal; several fossiliferous limestone; Ames limestone bed at top.
ALLEGHENY	Vanport		Cyclic sequences of shale, sandstone, limestone, and coal; contains Brookville coal at base and Upper Freeport coal at top; within group are the commercial Vanport limestone and Kittanning and Clarion coals.
		Pa	

GEOLOGY MAP LEGEND

REFERENCE:

GREATER PITTSBURGH REGION GEOLOGIC MAP
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